1961

The Effect of Stimulus Differentiation and Intertrial Interval on Spontaneous Alternation Behavior in Rats

Vernon Stephen Bisese
College of William & Mary - Arts & Sciences

THE EFFECT OF STIMULUS DIFFERENTIATION AND INTERTRIAL INTERVAL ON SPONTANEOUS ALTERNATION BEHAVIOR IN RATS

A Thesis

Presented to

The Faculty of the Department of Psychology

The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

By

Vernon Stephen Bisese

1961

APPROVAL SHEET

This thesis is submitted in partial fulfillment of

the requirements for the degree of

Master of Arts

Vernon Stephen Bisese

Author

Approved, May 1961:

Stanley B. Williams

Stanley B. Williams, Ph.D.

Peter L. Derks

Peter L. Derks, Ph.D.

E. Rae Harcum

E. Rae Harcum, Ph.D.

3

ACKNOWLEDGMENTS

The writer wishes to express sincere appreciation to Professor Stanley B. Williams for his patient guidance and encouragement throughout the investigation. Many thanks to the staff and the graduate students of the Psychology Department for the many kindnesses that helped to make this investigation possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The purpose of this study is to compare the effects of stimulus differentiation and intertrial interval on spontaneous alternation behavior in rats.

An experimental situation was devised in which rats were given pairs of trials in a simple T maze. Tactual and visual stimuli were varied along dimensions that provided three levels of stimulus discriminability between the arms of the T. Intertrial intervals of 15, 30, and 150 seconds were tested as variables within these stimulus conditions.

The frequency of alternation was observed among 36 subjects for 16 consecutive days. Although, the degree of stimulus differentiation did not prove to be a significant variable, there was some slight evidence that it did affect alternation frequency. The intertrial interval was a significant variable affecting alternation. The 30-second interval group had reliably more alternations that either the 15-second or the 150-second groups.

It is suggested that alternation behavior is affected by two factors, both of which increase simultaneously with different rates of acceleration with greater stimulus discriminability. As one of the factors seems to be a positive correlate of alternation and the other, a negative correlate; it was suggested that their summation yields an effective alternation tendency which first increases and then decreases as the stimulus dimensions become more differentiated.

The data also show that alternation performance improves during the latter half of the experiment.

THE EFFECT OF STIMULUS DIFFERENTIATION AND INTERTRIAL INTERVAL ON SPONTANEOUS ALTERNATION BEHAVIOR IN RATS

INTRODUCTION

Apparently, spontaneous variability in the behavior of organisms has led psychologists to postulate drives, both primary and secondary, that motivate curiosity, exploratory, or self-stimulating behavior. Any factors that may seem to determine whether behavior patterns will be stereotyped or variable are naturally of extreme interest, for one goal of psychology may be said to be to assign determiners to seemingly random behavior. Behavior variability has often been studied by manipulation of variables believed to affect drive, inhibition, reinforcement, etc. However, the possibility that it is related to such perceptual phenomena as binocular rivalry, ambiguous figure fluctuation and flicker-fusion frequency, as well as to probability bias, has been suggested by Walker (1955). The demonstration of even a remote association between these variables and molar, adaptive behavior justifies continued intensive study of the variables.

Spontaneous alternation of maze choice-points is one phenomenon that lends itself particularly well to the study of behavior variability. Spontaneous alternation refers to the behavior that organisms characteristically display on a pair of trials or a sequence of successive trials in a simple T or Y maze. The T maze either as a single unit or arranged in linear series has long been used for the study of alternation because it is simple and provides an environment that can be controlled effectively and varied systematically. If the sequence of trials is in close temporal order, the rat alternates its choice of right and left arms more regularly than is expected on the basis of chance (Dennis, 1939; Riley & Shapiro, 1952; Sutherland, 1957; Walker, 1956).

The Time Factor

Some of the earlier studies in spontaneous alternation were carried out to determine the duration of stimulus trace or symbolic processes in lower animals. Dennis (1939) and Heathers (1940) found no significant alternation for intervals beyond two minutes; Montgomery (1951) found no significant alternation for intervals beyond a minute. Other studies using slightly different apparatus designs and different procedures with T and Y mazes found the persistence of spontaneous alternation over much longer intervals. Walker (1956) tested rats in T mazes at 21 intervals ranging from 15 seconds to four hours and 16 minutes and found alternation varying around 75% for periods up to 60 minutes followed by an abrupt drop to chance level at 90 minutes. Walker's maze was constructed so that stimulus aspects of the two choice arms were highly differentiated, i.e. in grade of wire flooring and achromatic contrast of the walls. Other investigations have found a similar persistence of alternation over longer intervals by employing forced choices before the free trial. Zeaman and House (1951), for example, obtained 61% alternation with a 60 minute intertrial interval when they gave one forced trial before the free trial. They also found alternation for periods up to 12 hours after 10 forced trials to one arm. Rothkopf and Zeaman (1952) obtained 71% alternation with a 30 minute intertrial interval between forced Trial 1 and free Trial 2. Where reward is contingent on Ss' alternating, alternation has been found after a five-hour interval (Ladieu, 1944; Petrinovich & Bolles, 1957).

Response Factor

Zeaman and House (1951) explained the motivational force of spontaneous alternation in terms of the physical response. The execution of a turn in one direction produces an increment of fatigue which tends to inhibit that same turn on the second trial. Because fatigue dissipates with time, the decrease of alternation, with increased intertrial interval, would be the natural consequence. This response based explanation is derived from the earlier notion of "work decrement" which was reviewed in 1934 by E. S. Robinson in A Handbook of General Experimental Psychology. The "work decrement" is a resistence to repetitions of all sorts and it was conceived as an effect of the relative refractory phase. Dodge (1917) suggested that the relative refractory phase which is easily demonstrable in nerve and muscle tissue may also be present in more elaborate mental processes.

Hull defined his concept of reactive inhibition, I_r, as a certain increment of a fatigue-like substance or condition produced in the organism with each response evocation, having the capacity to directly inhibit the power of S to evoke R, and having the further property of dissipating with time alone. The total amount present at each response was defined as a positively accelerated function of energy expenditure consumed in the execution of the act. The dissipation was defined as a negative exponential function of time following the act (Hull, 1943). The concept of I_r served adequately as an empirical summary of the main data of the earlier studies (Heathers, 1940; Riley & Shapiro, 1952; Montgomery, 1951) where an inverse relationship over short intervals was found between intertrial interval and percentage alternation. However, Walker's discovery in 1956 of a sustained alternation up to 90 minutes, followed by a sudden disappearance, cast considerable doubt on the decay function of this fatigue condition or I_r.

Stimulus Factors

Meanwhile, Montgomery (1952) and Glanzer (1953b) both felt that alternation behavior was not sufficiently explained by a hypothetical construct like I_r that placed most emphasis on response components such as energy and fatigue. They argued that spontaneous alternation was more dependent on the sensory process, e. g. the stimuli associated with a particular choice. Therefore these experimenters used cross-shaped mazes with gates situated at the choice-point so as to make possible a simple T maze where the starting stem could be used from each of two opposite directions. In such a maze rats can be put in, say, the north starting stem for Trial 1 and in the south starting stem for Trial 2, so that stimulus and response components that are normally covariate are pitted against each other. Since Ss could alternate either the stimulus or the response in this maze, the relative dependence of alternation on the two components could be assessed experimentally. Both investigators concluded from their data that the major basis for alternation was the external stimuli, not the response. As a consequence of these findings, Glanzer proposed a new theory (see page 13 for full account) to account for spontaneous alternation behavior in terms of a stimulus process. His theoretical system is based on the concept of stimulus satiation, $_{s}I$, which in its formal properties is very similar to I_r. The major proposition of this theory is, "Each moment an organism perceives a stimulus-object or stimulus-objects, A, there develops a quantity of stimulus satiation to A." (Glanzer, 1953a)

Walker, too, used the cross-shaped maze for a similar experimental analysis (1955a). His experiment, somewhat more elaborate, was designed to determine the relative importance of three variables: intramaze stimuli, extramaze cues (place), and the response. To his cross-shaped maze rollers were attached to the underside, so it could be rotated; and hence, he could pit the extramaze cues against the intramaze stimulus and response cues simultaneously. Walker's data supported the conclusions of Montgomery (1952) and Glanzer (1953b) and further emphasized the primary importance of the intramaze stimuli. Place and response were in second and third order, respectively.

It was then argued by Walker (1955b) that the motivation of alternation was in the hands of the experimenter to a considerable extent. Stimulus, place, or response variables could be made maximally important by increasing the distinctiveness between any two choices for any of the determiners. Satisfactory demonstration of this argument was made regarding the response determiner (Walker, 1955b). The T maze was constructed in such a way that selection of either arm required distinctive locomotion in three dimensions through a choice-point region. Response was found to be a more effective determiner of alternation when the proprioceptive feedback of the physical response was qualitatively distinctive. Hence, response variables may, themselves, be thought of as proprioceptive stimuli.

We may say, then, that a great deal of evidence has accumulated to emphasize the crucial importance of stimuli of various kinds as critical determiners of alternation behavior. However, the empirical validation of all of Walker's argument and, indeed, of Glanzer's and other theories, is not yet complete. For example, the stimulus similarity hypothesis offered by Walker supposes a direct relation between degree of stimulus differentiation in the two arms of the T maze and percentage of alternation. This same similarity hypothesis is an explicit and integral part of Glanzer's (1953a) theoretical system. Deduction 5 from his theory states that, "In the simple two-alternative situation, as stimuli differentiating the alternatives are eliminated, spontaneous alternation will decrease." Nevertheless, and in spite of all of the evidence cited above, several direct tests of the similarity hypothesis have failed to confirm the hypothesis. Recently, for example, Dember and Roberts (1958) found no difference whatever in the percentage of alternation between a group of blinded rats and a normal group. Jackson's (1941) early study varied the angle of the arms of the maze at 15, 50, and 180 degrees and found no difference in percentage of alternation. So, there remains some doubt as to the generality of the stimulus hypothesis.

Montgomery (1953) did find a decrement in exploratory behavior (that may include alternation) which increased as the stimulus situations were made more similar. It is to be noted here that "exploratory drive" may be thought of as comparable to "stimulus satiation"; if the animal is governed by either, its behavior will be continuously varying. Montgomery observed exploratory activity in H-shaped mazes that varied in the black-white dimension, thus permitting an experimental manipulation of stimulus similarity.

Certain indirect support for the similarity hypothesis has also been found in other studies. In two (Dember & Millbrook, 1956; Kivy, Earl, & Walker, 1956), rats were given a pre-choice stimulus exposure by being placed at the choice-point. Subsequently, the rats were to choose between two arms that differed in amount of intensity-change from that of the exposure period. Both studies showed the more dissimilar alternative (i.e. the greater intensity-change) was selected by the rats.

Neurological Factors

A marked decrease in alternation scores following frontal lesions was found by Morgan and Wood (1943) while other lesions in the occipital and parietal lobes were either far less effective or not effective at all. The relevance to the similarity hypothesis of this study is based on the plausible assumption and on some evidence that the integrity of the frontal area is necessary for controlling the mechanisms of recent memory and hence, retention of a discrimination.

Interdependence of Time, Response, and Stimulus Factors: Theoretical Appraisal

A review of all these studies also reveals that similarity of maze arms characterized the mazes of those earlier experiments which found the disappearance of alternations after brief intervals. Where Walker (1956) found the persistence of alternations over long intervals, it is important to note that his maze had goal arms that were highly differentiated from each other and also from the choice-point region. Walker had coarse wire mesh in the gray starting stem and choice-point region. One goal arm was black with mesh of four wires to the inch and the other was white with mesh of two wires to the inch. The differentiated wire mesh of the goal arms extended only twelve inches beyond the choice-point region; however, Sutherland (1957) also found a greater percentage of alternation where the two goal arms lead to different goal boxes rather than to a common goal box. He argues that alternation depends partly on the rat's anticipation of stimuli beyond the choice-point. If so, Walker might have found an even stronger alternation tendency had he extended the differentiated wire meshes and thus provided more salient tactual and kinesthetic cues throughout the goal arms and the goal boxes.

Granted that there may exist either a need to explore or a satiation process for environmental stimuli, does a change in stimulation in itself constitute a drive-reducing situation in Hull's sense? If so, Hull's reinforcement theory should not be overlooked. In this case, alternation is a response to monotony or stimulus-similarity-satiation, and reinforcement would be stimulus novelty. Hull's theory would predict, on this basis, the occurrence of alternation behavior even if response repetition is imposed on the organism, and also an increase of alternation directly related to degree of stimulus difference in the arms of the T maze. Note that herein is implied the notion that what has otherwise been considered a pair of trials becomes one trial, and even though repetition as well as alternation yields reinforcement, an alternation patterning permits the maximum reinforcement.

If this be considered, then, a learning and reinforcement situation, we would expect some positive transfer from the life habits of the rat, because the sequential responses required by the situation amount simply to locomotion through a path, a turning response at the choice-point, and proceeding down another path, all of which the average rat has done many times. These responses must be considered as probably already overlearned before the experiment by an organism that has sought environmental and physical stimulation throughout life. Alternation is, therefore, a response that mature animals would display according to reinforcement theory if a stimulus drive exists. Interference would be expected, of course, as a result of other drives, such as fear, that often instigate stereotyped behavior. Glanzer (1958) also mentions the possibility of an initial rise of exploratory activity, before the decay function, attributed to the reduction of fear. Glanzer (1953b) and Montgomery (1952) have supplied formidible evidence against the concept of reactive inhibition as a major determiner of alternation behavior by pitting response alternation against stimulus alternation. However, reinforcement theory need not be totally discounted as an explanation since the I_r of one turning response is obviously small and animals in these experiments were given only two trials each day. Such a small accumulation would be considered negligible compared with the greater amount of reinforcement proposed on the basis of some curiosity, exploratory, or stimulus-seeking drive that is easily incorporated in reinforcement theory.

Walker's theory (1958) conceives the spontaneous alternation behavior as dependent on a central neural event, an action decrement which is followed in time by an increment (learning). Walker's system also includes roles for motivation and reward. He contends that reward, when it is contiguous with the action, is an "emphasizer" producing a greater reaction decrement followed in time by an increment. The more reinforcement, the more rapid the recovery from the decrement, and the greater the eventual increment. This theoretical system also proposes the similarity hypothesis by inference. A "stimulus drive" is reduced (or satisfied) to a greater extent where the choices are more discriminable. The action decrement that follows would more strongly insure an alternating choice by the rat with more discriminable choices.

Montgomery (1952b) makes alternation a special case of exploratory behavior which emerges from a curiosity drive aroused by novel stimuli. The strength of the tendency aroused by this drive is a decreasing function of time of exposure. Similarly, Berlyne (1960) uses the concept of a curiosity drive aroused by novel stimulation of an organism's receptors.

Glanzer's (1953a) system, based on a concept of stimulus satiation, $_{S}I$, is the most far ranging and inclusive one that we have today. $_{S}I$ like I_r predicts the occurrence of alternation behavior, the dissipation of alternation over time, a direct relation between alternation and the number of forced trials to one alternative, and an inverse relation between alternation and the number of successively massed trials. Being a stimulus process, $_{S}I$ also predicts the stimulus generalization of alternation, response repetition with reversal of stimuli between trials, and a direct relation between amount of alternation and intertrial interval or length of exposure to an alternative. His theory is worth stating in more detail.

Glanzer's Theory

Glanzer proposes a postulate to account for spontaneous alternation behavior: "Each moment an organism perceives a stimulus-object or stimulus-objects, A, there develops a quantity of stimulus satiation to A."

i. The same amount of stimulus satiation develops in each successive moment. The total amount developed is, therefore, an increasing linear function of time.

ii. There is a loss of part of each quantity of stimulus satiation in each successive moment. The amount of stimulus satiation remaining from each quantity is a decreasing negative exponential function of time.

iii. Stimulus satiation developed to A will be generalized to other stimulus-objects B. The amount of generalized stimulus satiation is an inverse function of the discriminability of A and B.

iv. The various quantities of stimulus satiation combine additively.

v. Stimulus satiation reduces the organism's tendency to make any response to A.

Two corollaries follow from the postulate:

Corollary I. As long as an organism remains perceiving A, the amount of stimulus satiation it has to A at a given moment (that is the total amount developed minus the total amount lost) is an increasing negative exponential function of time.

Corollary II. When an organism stops perceiving A, the amount of stimulus satiation it has to A at a given moment is a decreasing negative exponential function of time.

From these, Glanzer draws certain implications, of which the following are of most concern to the present issue:

Deduction 5:

In the simple two-alternative situation, as stimuli differentiating the alternations are eliminated, spontaneous alternation will decrease.

Deduction 8:

In the simple two-alternative situation, the more highly differentiated the alternatives, the longer the time interval between trials necessary for the disappearance of spontaneous alternation.

Summary of Introduction

Single unit T and Y mazes have long been used to study the choice-point behavior of rats. There is a general agreement among investigators that spontaneous alternation occurs when the duration of the intertrial interval is only one or two minutes. A study by Walker in 1956 demonstrated the persistence of alternation above the mathematical chance level of 50% for intervals as long as 90 minutes. This example of orderly and variable behavior has been found to depend in some way on perceived stimuli and stimuli associated with motor responses involved in making the choice. Consequently, theoretical explanations of the phenomenon all involve some form of concept which describes a self-stimulating drive--curiosity, exploration, or stimulus satiation. Each theory makes spontaneous alternation a stimulus process. Each makes the assumption that alternation will increase as the degree of stimulus difference between the two choices increases. The full demonstration of this similarity hypothesis is still incomplete; nevertheless, it is critical for the validation of stimulus-based theories. The most elaborate and all-inclusive theory is Glanzer's (1953a). He specifically hypothesized increased alternation with greater stimulus differentiation and also the persistence of alternation over longer intervals with greater stimulus differentiation.

STATEMENT OF THE PROBLEM

The present experiment is considered a direct test of the similarity hypothesis and specifically for Deductions 5 and 8 of Glanzer's theory. The first purpose was to determine the effects of varying degrees of stimulus similarity on spontaneous alternation behavior in rats. To this end, both visual and tactual stimuli were varied in the two arms of a T maze providing three levels of differentiation that were paired in opposing arms to create a condition of high similarity (identical stimuli), a condition of intermediate similarity (similar stimuli), and a condition of high dissimilarity (different stimuli). The present experiment also tested the effects of intertrial intervals of 15 sec., 30 sec., and 150 sec. on alternation behavior. In addition to choice-point behavior, latency measures were taken to provide additional evidence for the strength of alternation tendency under each condition and to offer a response measure about which to speculate situational attractions in various parts of the maze under different stimulus conditions.

METHOD

Subjects

The Ss used in this experiment were thirty-six male rats of the Sprague-Dawley strain, approximately 120 days of age, purchased from Charles River Breeding Laboratory. Previous to use in this experiment all animals had been housed in small individual cages for about six weeks. Food and water were provided ad libitum until two weeks before the pretraining period. Each S was fed three Purina chow pellets daily during the pretraining period and the experiment. No infections or illnesses were observed in any Ss prior to or during the experiment.

Apparatus

The T maze for this experiment was constructed of 3/4 in. white pine. A basic maze was designed to contain interchangeable inserts for goal arms and goal boxes. The starting stem and goal arms were 18 in. long and 4 in. wide. The starting box was 6 in. by 4 in., and the goal boxes were 6 in. by 9 in. The walls of the maze extended 4 in. above the maze floor. Guillotine type doors of Masonite were fitted to the basic maze at the start box, at the two sides of the choice-point region leading into the arms of the T, and at the goal boxes. The starting stem, including the start box and choice-point region was gray. The floor of this section was made of brass grids about 1/2 in. apart. The roof was constructed of 1/4 in. wire mesh and was also painted gray.

Three varieties of inserts were used for goal arms and goal boxes. A pair of white inserts had 1/2 in. wire mesh for the floor and roof. A pair of gray inserts had 1/4 in. wire mesh and a pair of black inserts[1.] had fine 1/16 in. standard window screening.

Three standard clocks recorded the following:

1.) Time to the choice point.
2.) Time to complete selection of an arm.
3.) Time to get inside the goal box.

A light regulated by a relay timer was used by E to maintain a constant total time for each S in the goal arm and box. The circuit was completed by closing the door to the goal arm. A clock with a sweep second hand was used to control the time of the intertrial interval.

Switches located above the guillotine gates operated a 28-volt stepping relay which in turn operated the standard clocks. At the choice-point region, the floor was pivoted and slightly tilted toward the approach of S. The weight of S upon the grid depressed the floor to complete a circuit for recording choice-point time.

An aluminum scoop was used to hold S during the intertrial

1.) The term "insert" will hereafter refer to one goal arm and one goal box of the same characteristics, and only the color will be used to specify a particular set.

interval.

A five-foot unpainted runway was used for pretraining. It was 3 1/2 in. wide and 7 in. high. Three guillotine type doors of Masonite were located 8 in. and 2 ft. 6 in., and 4 ft. 4 in. from either end. The roof was wire mesh.

Procedure

Ss were fed three Purina chow pellets each evening for two weeks prior to pretraining. They were handled approximately fifty minutes throughout this period. During pretraining, each S was fed immediately following its trials, which occurred between 5:00 P. M. and 10:00 P. M. each evening.

Four days of pretraining consisted of handling the animals and giving them four trials each day in the straight runway to small food pellets in the goal box. The pellets were made of Purina chow powder and water and were approximately 1/8 in. in diameter. On each trial, gates in the runway were dropped behind the S to accustom it to the process.

The T maze was set in a partially soundproof room inside of the animal cage room. It was set 4 in. above the floor over a black oilcloth surface. A cheesecloth screen completely surrounded the sides of the maze from the ceiling to a level with the maze. A 45-watt bulb was suspended 40 in. over the starting stem.

E operated the gates behind the starting stem with a system of strings and pulleys. After S was placed in the start box, E lifted the gates to the end arms and goal boxes. The gate to the starting stem was lifted to release S and this gate operated a switch that started Clock 1. When S reached the choice-point region, his weight depressed the grid which closed a circuit that stopped Clock 1 and started Clock 2. When E lowered the gates behind S in the end arm Clock 2 stopped and Clock 3 started. This also turned on a light inside the experimental room that allowed E to measure the 15-sec. interval before removing S from that side. When S reached the inside of the goal box and the gate was lowered, Clock 3 stopped.

When the 15-sec. exposure interval was completed, E removed S for 15-, 30-, or 150-sec. according to the group assignment of S. Therefore, three latencies, starting, choice-point, and latency to the goal box, were taken. The second of the pair of trials was conducted like the first, and at its completion, S was returned to its living cage and fed three Purina chow pellets.

In order to keep the changing of inserts at a minmum, E ran all Ss under one stimulus condition consecutively in one block each night. To control for diurnal effects, the order of these three blocks of Ss was rotated so that a block of Ss run first one night was run third the next night, and second the following night. Where there are different stimulus conditions on the two sides, i.e., white and gray, or white and black, they were reversed each day to control for preferences for a stimulus on a particular side.

The same kind of pellets used during pretraining were available to S in either goal box on an aluminum tray, so situated that S had to make the same turn in the goal box that it made at the choice-point. If S did not get to the goal box in the 15 second exposure interval, no food reinforcement was given.

E used an aluminum scoop to aid in the handling of S and to minimize personal contact during the intertrial interval. However, S spent the last five seconds of this interval in the start box awaiting Trial 2.

Design

A three by three factorial design had nine groups of Ss to represent the conditions obtained by pairing three stimulus conditions with three intertrial intervals. The 36 Ss were assigned to nine groups of four Ss each according to a table of random numbers. The three stimulus conditions represent the degree of difference between the visual and tactual stimuli, i.e., achromatic intensity and grade of wire, in the opposing arms of the T-maze. The intertrial intervals were 15-, 30-, and 150-sec.

For a condition of identical-stimuli, there were two white inserts (W-W) in the arms of the maze; for a condition of similar-stimuli, there was a white and a gray insert (W-G, G-W); and for a condition of different-stimuli, there was a white and a black insert (W-B, B-W).

Ss were given a pair of trials with the assigned condition on each of 16 consecutive evenings between 5:00 P. M. and 10:00 P. M. The running order for the nine groups over three days is shown in Table 1. Each three days this order is repeated. Neither the order of Ss within a group nor the order of the three intertrials interval groups within one stimulus condition varies on any day.

TABLE I

Running order of nine groups for each three consecutive days.

Blocks	Days		
	1	2	3
	I-15	S-30	D-150
Block 1	I-30	S-150	D-15
	I-150	S-15	D-30
	S-30	D-150	I-15
Block 2	S-150	D-15	I-30
	S-15	D-30	I-150
	D-150	I-15	S-30
Block 3	D-15	I-30	S-150
	D-30	I-150	S-15

RESULTS

The results of this experiment were essentially mixed with respect to the hypotheses. Alternation scores for the nine conditions are shown in Table 2.

On each of the sixteen test days, the mean percentage alternation was 69.44%. Fig. 1 shows the mean percentage alternation for all *S*s as a function of days. The sign test for related samples as presented in Siegel (1956) was done on the alternation scores for day 8 and day 9,—two days which show the greatest score discrepancy. A z-score of 1.33 ($p = .18$) indicates that the alternation performance on these two days is not significantly different.

An analysis of variance is given in Table 3. The degree of stimulus differentiation in the arms of the T-maze did not reliably affect the frequency of alternation. The length of the intertrial interval was a significant variable affecting the frequency of alternation. Therefore, each group of *S*s at one intertrial interval, which includes the three stimulus subgroups, were compared with every other interval group. The 30-sec. group had reliably more alternations than the 15-sec. group ($t = 2.47$, $p < .05$). The 30-sec. group also had reliably more alternation than the 150-sec. group ($t = 2.96$, $p < .01$).

TABLE 2

Total number and percentage of
alternations under
the nine basic conditions

	I		S		D		Mean	
Interval (sec.)	No.	%	No.	%	No.	%	No.	%
15	34	53.12	49	76.56	38	59.38	121	63.02
30	53	82.12	56	87.50	50	78.12	159	82.82
150	39	60.94	45	70.31	36	56.25	120	62.50
Mean	42	65.62	50	78.12	41	64.58	133	69.44

Figure 1. Mean percentage alternation for the 36 rats on each of the 16 consecutive days.

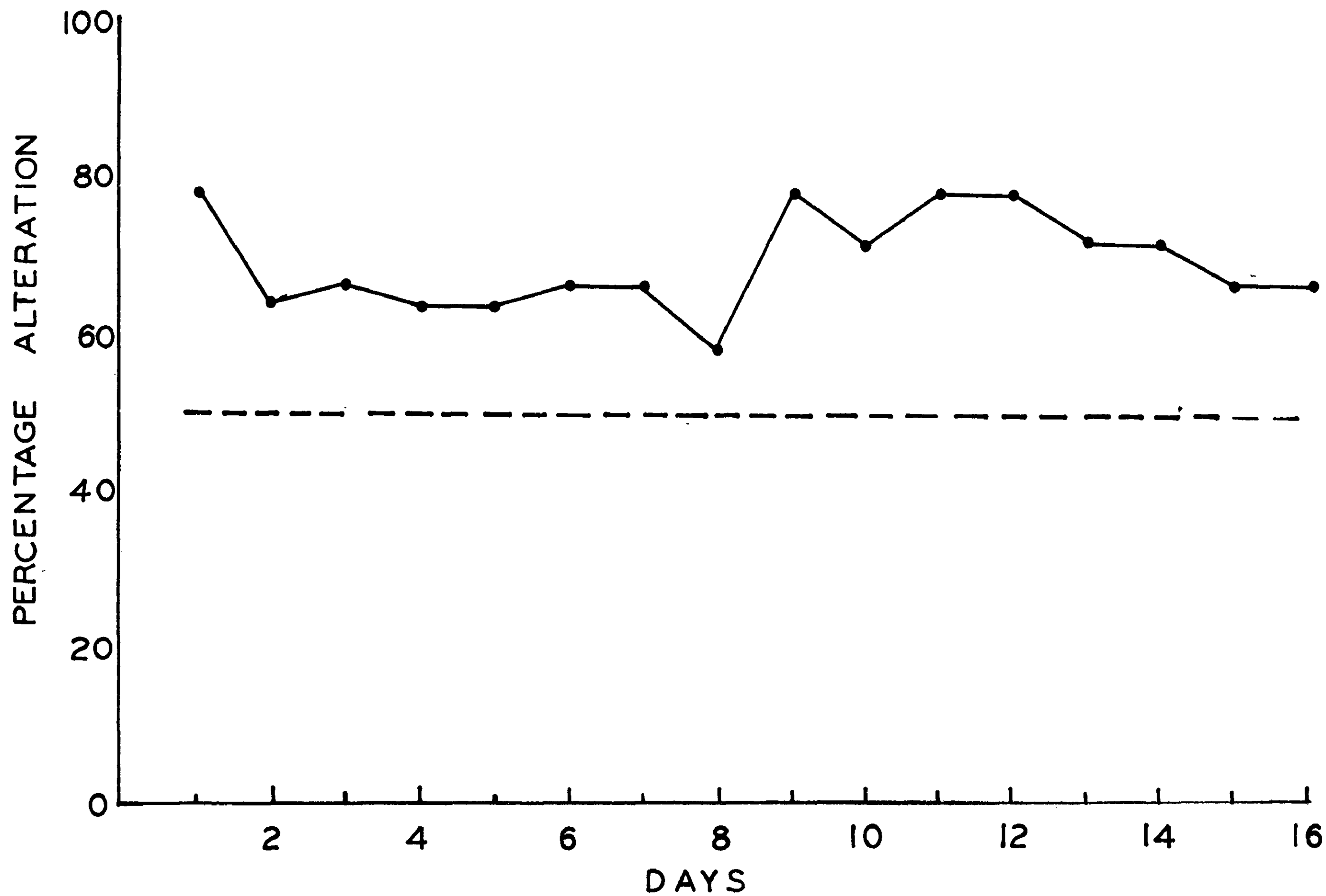

PERCENTAGE ALTERATION
100
80
60
40
20
0
2
4
6
8
10
12
14
16
DAYS

TABLE 3

ANALYSIS of VARIANCE

Source of Variation	Sum of Squares	df	Mean Square	F
Stimulus Differentiation	34.89	2	17.45	1.64
Intertrial Interval	82.39	2	41.20	3.86*
Interaction (S X I)	10.28	4	2.57	0.24
Within Cell	288.00	27	10.67	
Total	415.56	35		

* .05 level of confidence

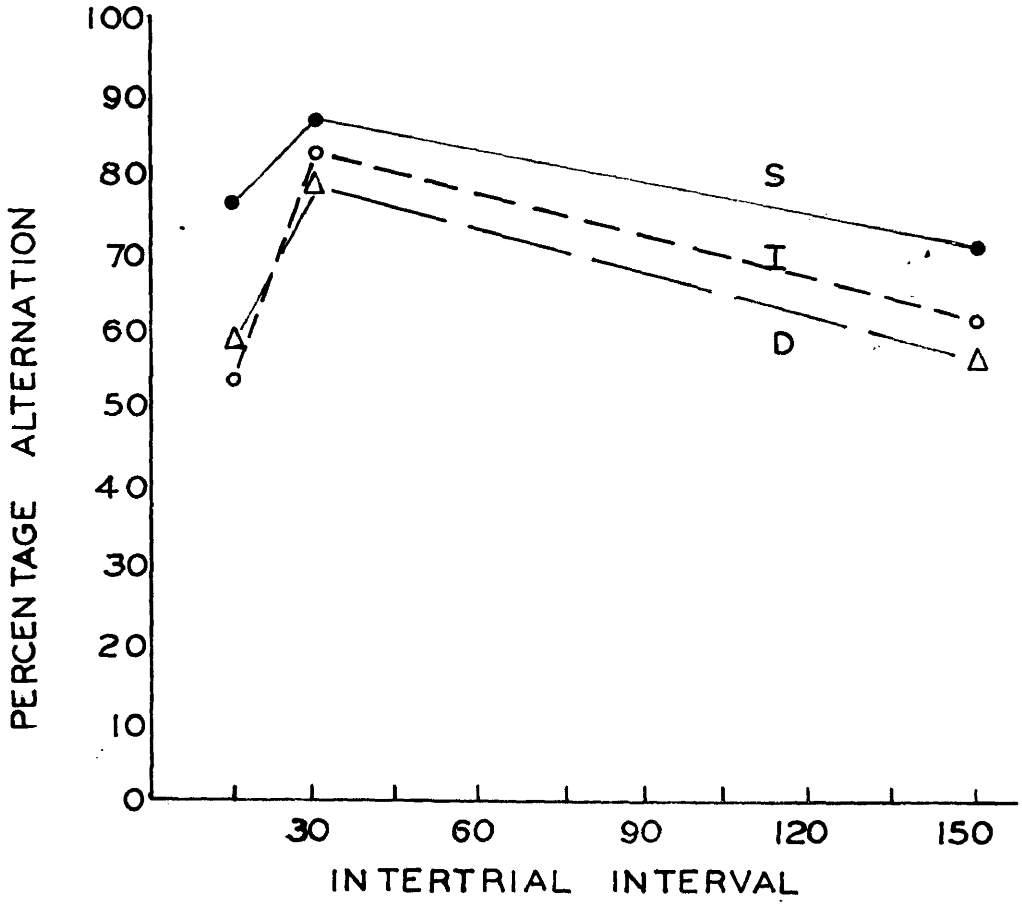
The 15-sec. and the 150-sec. groups were not reliably different from each other.

The mean percentage alternation for nine groups as a function of the intertrial interval is shown in Fig. 2. The mean percentage alternation after the 15-sec., 30-sec., and 150-sec. intervals are 63.02%, 82.82%, and 62.50% respectively. To determine if Ss alternated more or less than 50%, each of the thirty-six Ss was counted according to this criterion. The chi square of 13.44 indicated that a significant number alternated more than the "mathematical chance" of 50% of the sixteen trials ($p < .001$). When each of the interval conditions was individually tested with the chi square, it was found that the 15-sec. group ($\chi^2 = 4.08$, $p < .05$) and the 30-sec. group ($\chi^2 = 10.08$, $p < .01$) both had a reliable number of Ss alternating above the chance level. This was not found for total Ss of the 150-sec. interval condition ($\chi^2 = 1.33$).

Chi squares for the three stimulus conditions, including the three interval groups were 3.33 ($p > .05$) for the condition of identical-stimuli, 8.33 ($p < .01$) for the condition of similar-stimuli and 3.33 ($p > .05$) for the condition of different-stimuli. Only the condition of similar-stimuli had a significant number of Ss alternating above chance when all time interval groups were included.

In order to determine if Ss were alternating more on the earlier or the later trials in the experiment, each S was counted according to whether the majority of its total alternations

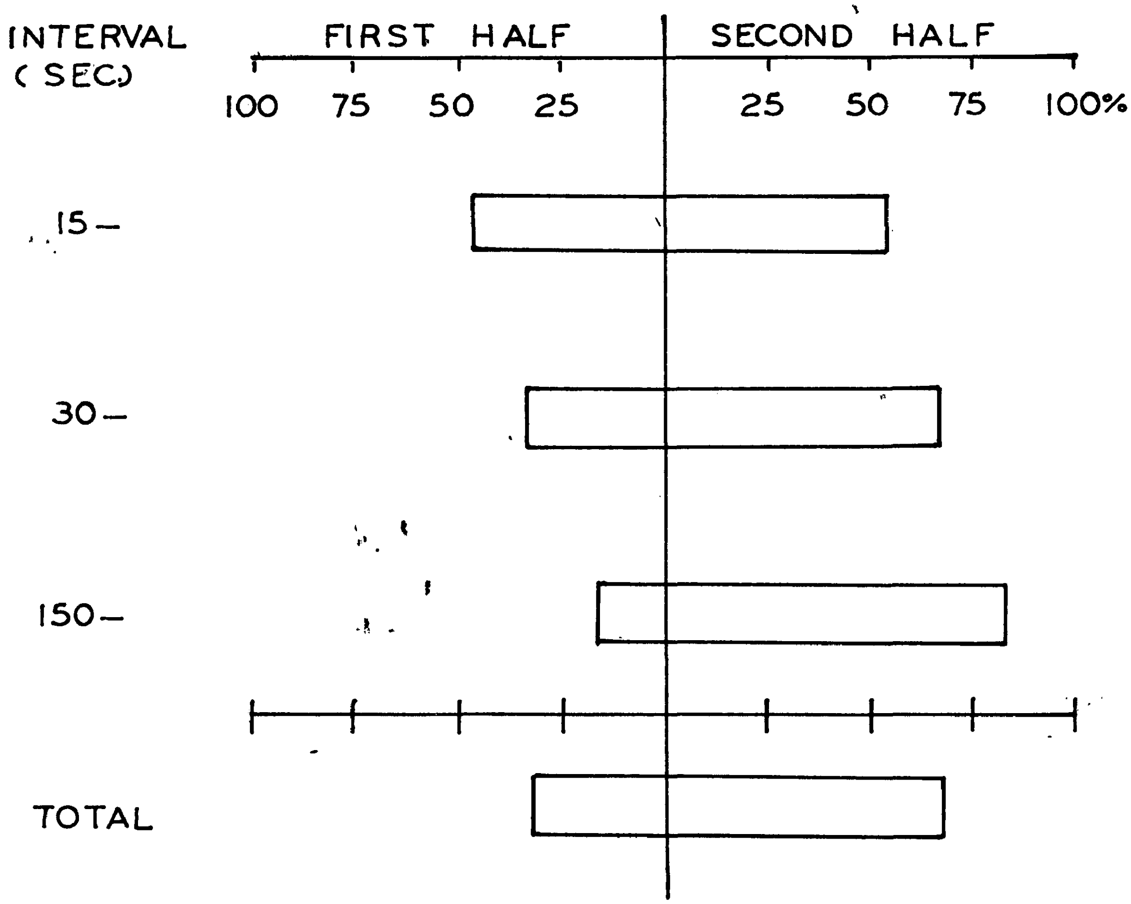
Figure 2. Mean percentage alternation as a function of intertrial interval for the three stimulus groups.


100
90
80
70
60
50
40
30
20
10
0
PERCENTAGE ALTERNATION
S
I
D
30
60
90
120
150
INTERTRIAL INTERVAL

occurred on the first eight days or the last eight days (Fig. 3). Chi square of 4.69 ($p < .05$) indicates that a significant number of Ss alternated more on the last eight pairs of trials in the experiment.

The behavior on Trial 1 was analyzed for the three stimulus groups in order to determine whether Ss showed preferences for particular stimuli. Where there was no difference in intramaze stimuli (W-W); 46.88% of the first trials were to the left and 53.12% to the right. For the similar-stimuli condition (W-G, G-W), the first turns are distributed exactly evenly with respect to choices of the white and the gray sides. For the different-stimuli condition, (W-B, B-W), 46.88% of the first choices were for the black and 53.12% for the white. The percentages given above obscure the fact that certain Ss were actually exhibiting preferences, but the number of Ss in one group that preferred one side or condition was about equalized by the number of Ss that preferred the alternate side. Therefore, an empirical probability of chance alternation was calculated for each S on the basis of Trial 1 behaviors by the formula $1-(A^2+B^2) = p_o$. (Dember & Fowler, 1958). By summing the squares of the percentages of both types of Trial 1 behavior for sixteen trials and subtracting this sum from 1, a percentage value is obtained that approximates more closely than 50% the *a priori* expectation of one S's alternation score. By subtracting this empirical probability value from S's actual percentage of alternation, the percentage of alternation above this *a priori* probability was

Figure 3. Percentage of subjects having the majority of alternations in the first half and in the last half of the experiment for total subjects and for three intertrial interval groups.

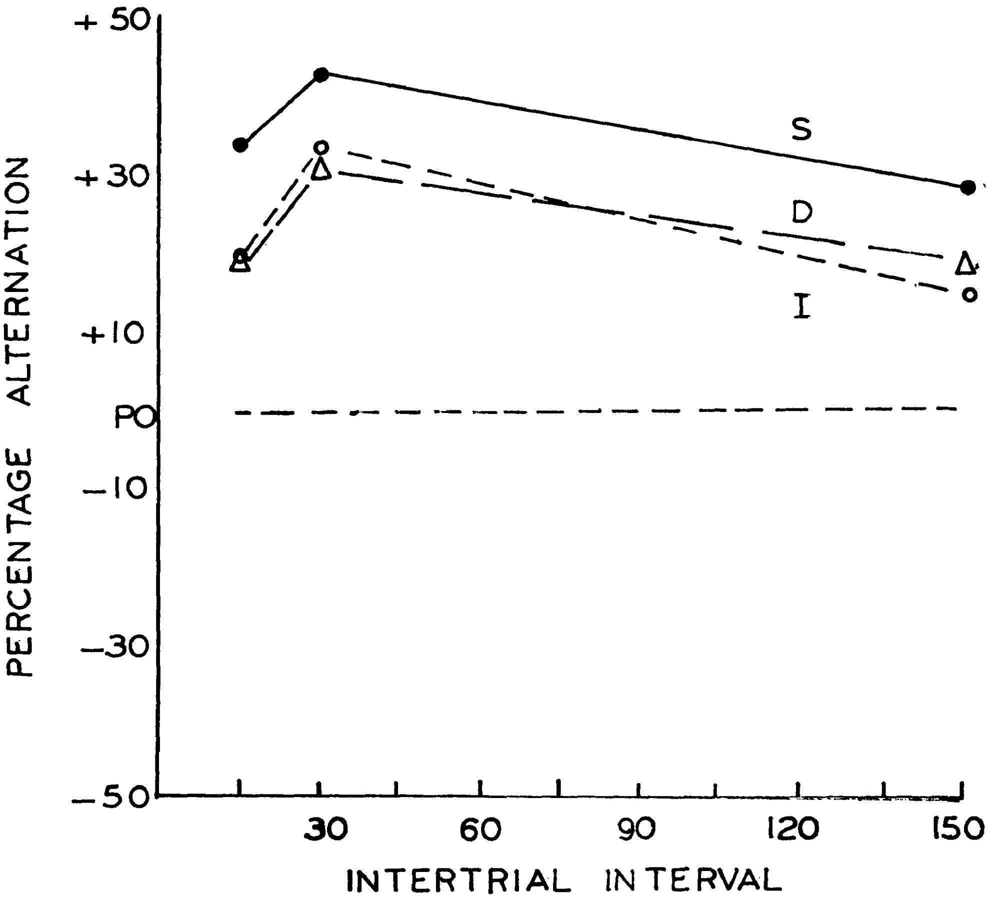


INTERVAL (SEC.)
FIRST HALF
SECOND HALF
100
75
50
25
25
50
75
100%
15—
30—
150—
TOTAL

obtained. The average of these percentages for the nine groups is in Fig. 4 as a function of the intertrial interval. Although the functions are maintained, a general increase in alternation above chance appears, and some of the peakedness of Fig. 2 is lost.

Analyses of variance were done on the following log mean latencies: first choice-point latency, second choice-point latency, second start time plus second choice-point latency. Stimulus difference was not a significant variable affecting these latencies. The intertrial interval was found to be a significant variable affecting the first choice-point latency. The 15-sec. group had reliably greater log mean latencies at the first choice-point than did the 30-sec. group ($t = 2.90$, $p < .01$).

Figure 4. Mean percentage alternations above the empirical probability for the three stimulus conditions as a function of intertrial interval.


+ 50
+ 30
+10
PO
−10
−30
−50
PERCENTAGE ALTERNATION
S
D
I
30
60
90
120
150
INTERTRIAL INTERVAL

DISCUSSION

The foregoing data suggest the following conclusions:

1.) The degree of stimulus differentiation in the arms of the T-maze did not reliably affect the percentage of alternation.

2.) The intertrial interval increase from 15 sec. to 30 sec. caused a greater alternation performance and a further increase in the intertrial interval from 30 sec. to 150 sec. caused the alternation measure to decrease.

3.) The number of Ss in the 15-sec. group and the 30-sec. group alternating more than 50% was large enough to say that some spontaneous alternation occurred in these groups.

4.) The number of Ss in the similar-stimuli group alternating more than 50% was large enough to say that some spontaneous alternation occurred in this group.

5.) Alternation was greater for Ss in the second half of the sixteen experimental days.

6.) The mean percentage of alternation is above the 50% level in the nine groups.

Because stimulus differentiation was not a reliable variable, Deduction 5 of Glanzer's system was not supported:

> "In the simple two-alternative situation, as stimuli differentiating the alternations are eliminated, spontaneous alternation will decrease.."

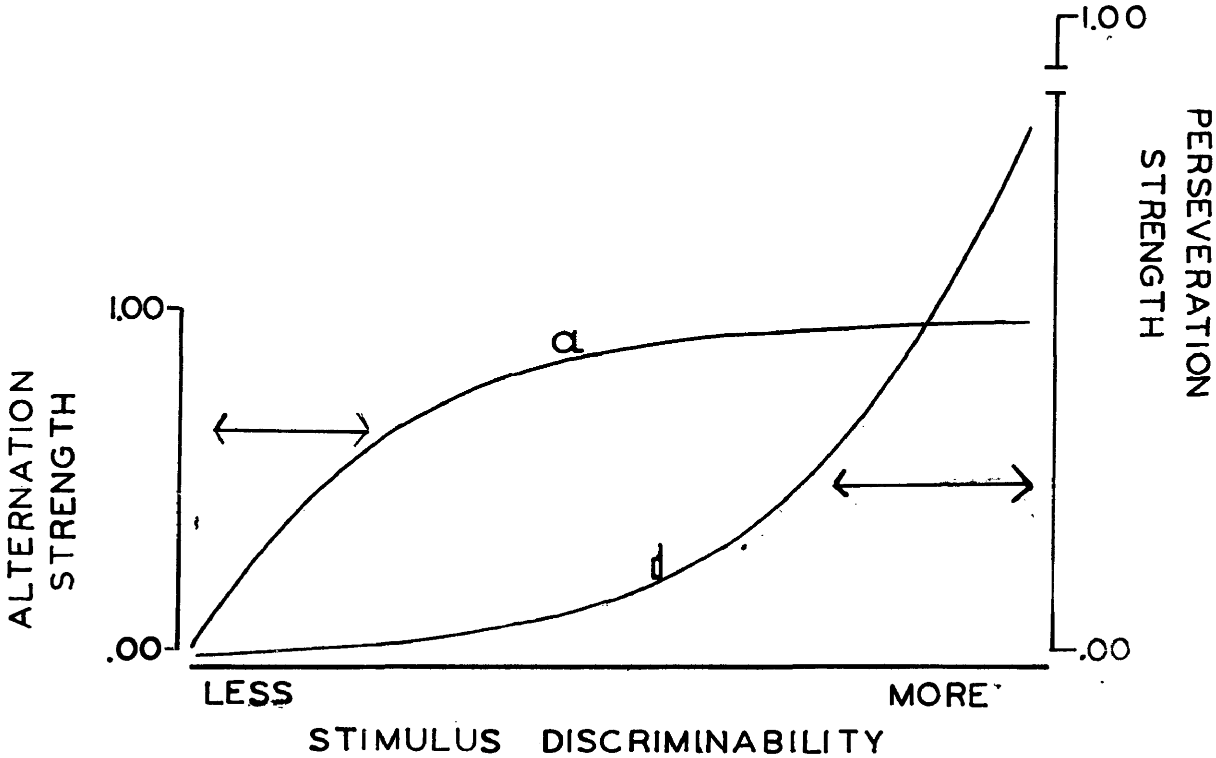
Although the three stimulus groups were not differentiated statistically, it is interesting to note that the similar-stimuli group had a greater mean percentage of alternation than the other two stimulus groups at each of the intertrial intervals. Because the same kurtic function is maintained by each of the stimulus groups, it seems probable that the clear overlap signifies the presence of a stronger alternation tendency in the similar-group. Some slight evidence of the similarity hypothesis is indicated by comparison of the identical- and the similar-groups. However, a comparison of these groups with the different-stimuli group suggest that the similarity hypothesis must be qualified as to the extent of the stimulus change which will induce greater alternation in the T maze. The results show that possibly more than one function increases with greater discriminability of choice.

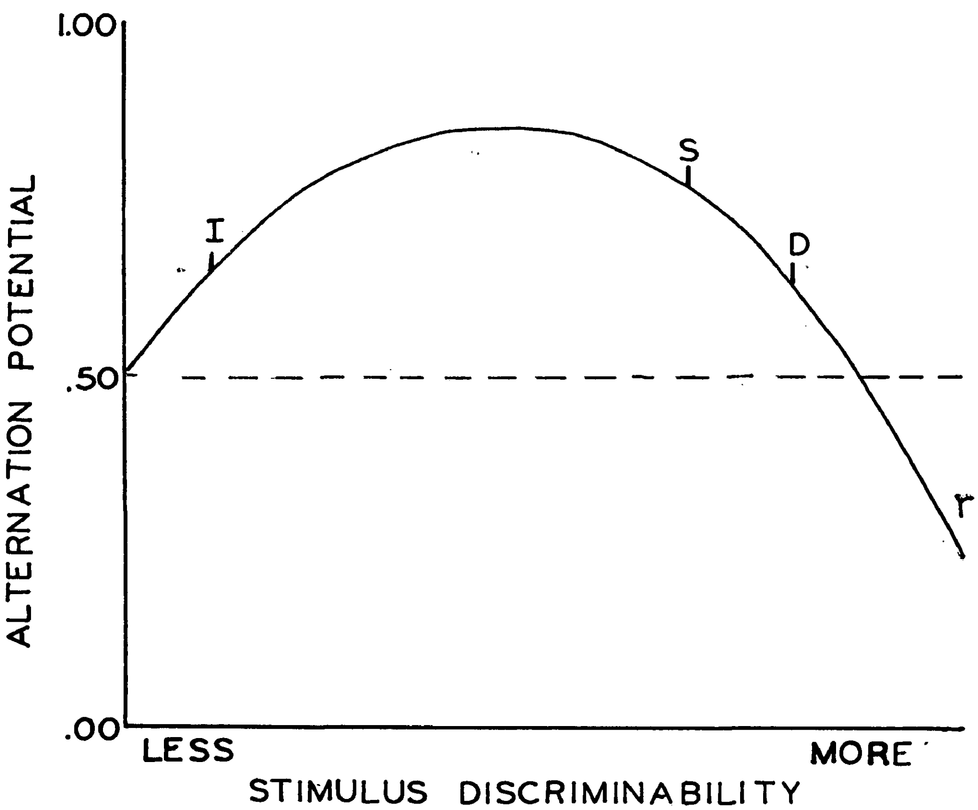
A theory

Let us suppose that the tendency to alternate is a negatively accelerated function of stimulus discriminability as described by function *a* in Fig. 5. The course of this function is based on stimulus satiation or an exploratory drive, and from the data of this experiment, it is inferred that the asymtotic value of this function is obtained after a small amount of stimulus change. A tendency to display more disorderly behavior could possibly rise simultaneously with this at a positively accelerated rate like function *d* in Fig. 5. The resultant function of *a* and *d* would initially rise and then fall with a decreasing positive acceleration (function *r* in Fig. 6). The

Figure 5. A positive correlate, $\underline{a}$, and a negative correlate, $\underline{d}$, of spontaneous alternation, as a function of stimulus discriminability between choices in the T maze.

Figure 6. The effective alternation tendency, $\underline{r}$, as a function of stimulus discriminability between choices in the T maze.


1.00
.00
ALTERNATION STRENGTH
a
d
PERSEVERATION STRENGTH
1.00
.00
LESS
MORE
STIMULUS DISCRIMINABILITY


1.00
.50
.00
ALTERNATION POTENTIAL
I
S
D
r
LESS
MORE
STIMULUS DISCRIMINABILITY

shape of r, effective alternation tendency, would be entirely dependent upon the strength of the two tendencies that comprise it. Accordingly, the relative alternation scores for the three stimulus groups represent three distinct positions (I, S, and D in Fig. 6) along the resultant function. The identical-stimuli group experienced the rising portion of the self-stimulating function, and the other groups experienced the asymptotic value of this function. If, in addition, the three groups experience three corresponding points along the aversive continuum, the relative differences among the three groups would seem reasonable. The decrease in alternation frequency, apparent in the different-stimuli group, is caused by the approaching intersection of the positive and negative functions.

The stimulus dimension that contributes the positive acceleration would be based on some aversive quality inherent in the changing side. This idea presupposes that the changing side must become increasingly unfamiliar to the organism and this suggests that harmful, frightening, or painful qualities become increasingly preponderant in that choice side. It is reasonable to assume that environmental stimuli that have been experienced very little, even as components of complex stimuli, are probably aspects of the stimulus dimension that inflict pain or danger. On the other hand, the changing stimulus dimension might make one side more attractive to the organism and the other side more aversive only by comparison.

Corresponding to this notion is the assumption that disorderly behavior might be induced through variables other than stimulus differentiation. As intertrial interval increases, the holding or lifting of Ss may contribute to disorderly behavior reducing the occurrence of alternation. Picking up S might have induced the positive function of disorderly behavior (and acted as a sort of disinhibitor) that lowered the alternation rate in the 15-sec. group. Also, it is probable that this startle reaction was largely dissipated before the end of the 30-sec. interval. Holding Ss over the long intertrial interval of 150 sec. might have induced the greatest handling disturbance. Consequently, a greater decrease in alternation occurred in this group.

Because of the failure in this experiment to find support for the similarity hypothesis, Deduction 8 of Glanzer's theory can not be supported.

> "In the simple two-alternative situation, the more highly differentiated the alternatives, the longer the time interval between trials necessary for the disappearance of spontaneous alternation."

The data indicates that with further increases of the intertrial interval, the similar-group which had the strongest effective alternation tendency would alternate over the longest interval.

Alternation did not drop to the 50% level for any of the intertrial interval conditions tested in the present experiment. This is similar to Walker's (1956) findings in that alternation persists after a one or a two minute interval. If Walker is correct in assuming that alternation persists for intervals as long as 90 minutes, then the care of Ss between trials becomes a critical factor. It should be noted here that Walker's animals were placed in cages during the intertrial interval when it was longer than 30 seconds. Since, in the present experiment, even the 150-sec. Ss were held during the interval, the lower alternation score was probably due to this procedure.

Ss alternated more in the last half of the experiment. One possible explanation in light of the above reasoning is that there was an adjustment being made by Ss that tended to decrease the slope of the positive function. The other explanation is that learning occurs in this situation and reinforcement with stimulus change actually strengthens the alternating choices. Fig. 3 indicates that there is a functional relationship between the intertrial interval and the rate of learning. However, it is impossible to distinguish whether learning was facilitated by the briefer intervals or whether the decrease of the positive function was facilitated by experiencing two trials in a briefer interval. If reinforcement theory offers the best explanation of the obtained data, we still fail to find a direct relation between stimulus difference and degree of reinforcement.

The 150-sec. group was improving in alternation performance in the second half of the experiment. More than 83% of these Ss had the majority of their alternations during the last 8 days. In comparison, 66.67% of the 30-sec. group and only 54.17% of the 15-sec. group had the majority of their alternations during the last eight days. The inference here is that with continued trials in the same situation the final alternation performance of the 150-sec. group would approach that of the other groups whose alternation scores were already more stabilized.

APPENDIX

Explanatory note: Following, are individual records of each animal's performance. The records are arranged according to the running order of Ss on the first day of the experiment. The first three and the last three entries in each column show the running times for the first and second trials, respectively, on each of 16 days. The three entries show in the following order, time to the choice point, time to complete selection of the choice, and time to reach the goal box for each of the daily pair of trials. The last two entries in the column designate the direction, either right or left, in which the S turned on the first and last trial.

Subject Number: 4

Group: I-15

Day	1	2	3	4	5	6	7	8
	8.31	6.21	4.95	1.60	6.16	5.74	1.24	4.63
	12.94	11.49	5.74	2.85	4.21	2.70	0.41	3.41
	9.51	9.59	2.80	5.00	2.62	2.08	1.96	1.90
	2.61	3.54	0.83	1.91	1.31	0.65	0.44	0.73
	4.34	7.07	2.68	2.13	2.23	1.25	1.78	0.27
	2.36	2.20	1.02	4.20	4.68	1.52	2.20	1.24
	L	L	L	R	R	R	L	L
	L	L	L	L	L	L	L	L

Day	9	10	11	12	13	14	15	16
	6.00	1.53	1.37	2.07	1.50	1.26	2.83	1.73
	8.45	3.24	2.05	3.47	7.54	1.20	2.66	4.93
	1.80	1.63	1.99	1.97	1.88	1.10	1.66	1.55
	14.29	2.08	1.03	1.01	0.74	0.56	1.37	0.71
	2.46	2.86	1.26	0.13	3.41	0.19	9.67	2.36
	1.43	1.30	1.58	2.40	1.19	0.84	1.45	2.51
	L	R	R	L	R	L	R	R
	R	R	L	R	R	R	L	L

Subject Number: 9

Group: I-15

Day	1	2	3	4	5	6	7	8
	11.87	50.92	7.47	111.03	101.89	47.66	30.11	50.30
	12.36	62.90	125.49	95.00	75.25	21.23	27.39	7.98
	15.00	15.00	15.00	15.00	15.00	6.07	5.43	5.74
	16.86	35.36	53.50	78.88	30.40	29.01	10.48	40.82
	74.39	131.22	20.79	81.18	23.51	0.16	37.61	10.06
	15.00	14.92	15.00	15.00	15.00	13.38	1.80	2.54
	R	R	R	R	R	R	R	R
	R	R	L	R	R	L	R	R

Day	9	10	11	12	13	14	15	16
	17.79	9.68	30.75	59.45	38.44	45.49	59.60	29.94
	40.21	22.76	22.49	30.23	1.08	2.44	30.56	1.97
	2.67	15.00	2.94	2.99	4.21	1.90	2.01	2.34
	23.85	3.71	27.46	4.81	9.97	3.95	5.30	2.01
	10.00	2.25	0.36	8.87	2.17	2.52	1.10	1.26
	1.50	3.28	3.97	1.85	1.27	1.31	1.58	1.38
	R	R	R	R	R	R	R	R
	R	R	R	R	R	R	R	R

Subject Number: 11

Group: I-15

Day	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	3.12	1.60	1.91	2.85	3.57	1.62	3.48	2.04
	37.58	59.23	89.59	121.71	84.41	88.15	101.56	62.64
	5.23	14.59	14.25	8.42	10.93	9.69	2.01	1.92
	4.77	4.60	1.00	21.26	0.76	1.08	1.39	0.78
	86.51	51.60	41.20	11.69	1.03	4.62	5.60	1.61
	5.97	11.73	15.00	2.09	13.30	8.66	2.74	1.42
	L	R	L	L	R	R	R	R
	L	L	R	R	L	L	R	R

Day	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
	0.43	1.62	0.54	0.71	0.60	0.60	2.27	0.50
	2.11	20.23	9.30	2.40	23.37	5.44	5.03	3.15
	0.84	1.57	1.53	1.91	1.81	2.40	1.97	1.57
	0.49	0.15	0.91	0.12	0.10	1.98	0.94	2.60
	1.99	1.35	1.57	0.43	1.96	1.43	1.09	1.11
	0.74	1.24	1.26	2.18	0.81	0.66	1.07	0.75
	R	R	R	R	L	R	R	L
	R	L	L	L	L	L	L	L

Subject Number: 28

Group: I-15

Day	1	2	3	4	5	6	7	8
	6.31	0.94	0.78	3.94	1.35	1.75	0.55	1.85
	6.32	6.66	9.99	11.00	20.39	26.66	53.11	22.29
	3.60	3.02	1.02	2.75	15.00	2.03	1.36	1.66
	5.01	4.65	4.31	3.50	2.30	1.62	1.33	9.18
	10.39	30.00	10.25	77.55	2.08	1.36	2.61	1.53
	4.56	14.77	2.34	2.61	2.12	1.66	6.94	1.81
	R	L	R	R	L	R	R	R
	L	R	R	L	R	R	L	L

Day	9	10	11	12	13	14	15	16
	6.64	11.80	2.52	8.47	2.48	12.17	4.12	3.45
	29.77	53.95	32.75	22.04	11.94	3.62	15.08	18.01
	4.96	2.11	2.35	1.82	1.77	1.69	1.87	1.61
	12.07	21.05	15.88	4.05	1.46	1.88	1.77	1.03
	1.65	13.84	1.06	2.16	1.24	0.83	1.27	4.08
	1.10	1.87	1.43	1.54	1.15	0.78	1.26	8.09
	L	L	L	R	R	R	R	R
	R	R	R	L	L	L	L	R

Subject Number: 31

Group: I-30

Day	1	2	3	4	5	6	7	8
	15.20	4.98	2.75	1.80	2.11	4.14	0.90	1.02
	16.93	29.78	27.41	25.73	5.90	2.30	2.12	1.15
	15.00	5.80	4.12	3.75	3.71	2.04	0.88	1.21
	10.92	2.50	1.26	1.58	1.01	1.26	4.65	0.95
	10.40	3.46	2.62	1.93	0.98	1.29	2.01	2.61
	15.00	2.77	1.68	2.60	0.71	1.16	1.83	0.80
	L	L	L	L	L	R	R	R
	R	R	R	R	R	R	R	L

Day	9	10	11	12	13	14	15	16
	10.44	2.50	1.76	6.93	0.43	2.40	1.57	1.71
	2.76	2.71	1.21	1.02	3.34	1.66	2.13	1.17
	1.23	1.65	1.06	0.84	0.27	1.64	1.54	2.03
	1.13	0.70	0.42	2.12	0.60	0.50	0.64	1.02
	1.65	3.35	1.15	1.49	1.83	1.19	1.09	1.20
	0.71	1.04	0.70	1.97	0.62	1.71	0.80	0.67
	L	R	R	L	R	R	L	R
	R	L	L	L	L	L	R	L

Subject Number: 15

Group: I-30

Day	1	2	3	4	5	6	7	8
	6.24	3.50	1.61	0.53	0.74	0.67	0.85	0.60
	4.57	6.88	3.28	4.55	3.45	0.59	2.84	2.04
	8.41	2.85	3.32	3.00	2.16	1.50	0.91	1.12
	5.20	3.68	0.78	0.58	1.12	5.30	0.41	2.20
	2.37	10.36	2.50	0.52	1.49	0.92	2.28	1.91
	4.28	1.52	1.39	0.52	1.22	1.23	4.11	2.44
	L	R	L	R	L	R	R	R
	R	L	R	L	R	L	L	L

Day	9	10	11	12	13	14	15	16
	0.65	5.48	2.96	2.06	2.35	2.98	5.14	2.05
	7.87	34.68	1.69	34.10	5.78	3.25	1.35	6.41
	0.82	1.85	1.43	1.53	1.75	1.50	1.50	1.39
	2.95	0.78	1.64	0.16	3.13	4.83	0.24	4.50
	1.12	3.11	2.07	2.98	1.46	1.88	2.30	13.67
	0.74	3.85	11.00	1.05	1.22	4.07	0.98	2.37
	L	R	R	L	R	L	R	L
	R	L	R	L	L	L	L	L

Subject Number: 32

Group: I-30

Day	1	2	3	4	5	6	7	8
	12.54	1.30	1.09	0.85	1.90	1.64	0.67	1.34
	3.57	6.65	3.26	7.05	3.96	1.90	3.75	4.44
	4.68	3.00	2.62	4.28	2.27	1.54	1.38	1.82
	11.24	0.72	3.85	0.90	4.44	1.51	1.31	1.59
	3.68	4.64	2.12	10.26	1.01	0.84	1.59	1.50
	4.51	1.42	4.58	3.62	1.46	1.36	0.69	1.21
	L	L	R	L	L	R	R	R
	R	L	L	R	R	L	L	L

Day	9	10	11	12	13	14	15	16
	0.60	2.75	1.80	0.88	0.82	0.64	0.10	0.57
	2.38	1.81	4.49	2.80	1.52	1.47	1.60	1.35
	0.66	4.09	1.04	1.66	2.24	0.74	1.12	1.29
	0.69	1.06	0.78	3.25	2.96	1.85	0.80	1.62
	1.90	2.35	1.24	1.13	0.43	0.68	4.25	2.26
	0.91	1.20	1.01	1.02	1.21	0.69	1.13	2.41
	L	R	L	L	L	L	R	L
	R	R	R	R	R	R	L	R

Subject Number: 35

Group: I-30

Day	1	2	3	4	5	6	7	8
	5.67	2.15	1.12	1.23	9.60	2.39	4.19	4.23
	2.58	8.42	3.30	5.42	5.65	8.42	5.32	35.90
	5.96	2.29	9.23	1.05	5.84	3.02	2.14	2.39
	3.93	4.61	1.25	1.15	3.59	4.92	1.11	5.54
	4.03	7.20	3.55	5.79	10.02	33.92	30.79	2.20
	3.73	3.05	1.70	1.86	2.98	2.88	1.15	1.93
	R	R	L	R	R	L	L	L
	L	L	R	R	R	R	R	R

Day	9	10	11	12	13	14	15	16
	2.92	3.06	1.83	4.11	5.80	2.11	2.74	7.20
	52.20	12.63	44.60	16.46	33.70	73.82	13.94	5.31
	2.70	2.45	1.95	2.21	2.63	1.63	1.72	2.07
	9.12	8.19	9.87	3.89	3.06	5.76	3.47	1.31
	6.64	20.98	4.84	5.38	3.34	1.46	2.54	1.72
	2.56	2.96	1.29	1.73	1.39	1.29	1.28	1.43
	L	R	L	L	L	R	R	R
	R	L	R	R	R	L	L	L

Subject Number: 8

Group: I-150

Day	1	2	3	4	5	6	7	8
	9.83	3.32	1.50	3.25	5.12	3.70	1.46	1.62
	7.98	2.58	1.70	9.01	5.53	1.00	4.27	5.12
	6.03	1.46	3.95	1.78	3.24	1.68	1.52	1.71
	4.83	2.17	6.81	1.58	1.56	0.87	0.68	2.30
	4.31	2.90	2.51	5.03	7.69	4.52	3.15	3.64
	3.61	1.21	2.76	0.90	1.78	1.64	0.98	1.05
	R	L	L	R	L	L	R	L
	L	L	R	R	L	L	L	L

Day	9	10	11	12	13	14	15	16
	0.77	1.78	1.30	1.06	1.23	1.62	1.35	1.25
	2.37	8.64	2.22	2.21	3.29	2.72	3.01	4.10
	0.79	1.51	1.18	1.44	1.37	1.45	2.01	2.19
	1.99	11.98	0.36	4.10	2.73	2.27	1.13	0.46
	3.93	1.02	10.18	2.59	1.75	4.71	3.75	2.21
	1.14	1.06	1.05	1.32	1.99	1.12	1.21	1.25
	L	L	L	L	R	R	L	R
	L	L	L	R	R	L	R	L

Subject Number: 16

Group: I-150

Day	1	2	3	4	5	6	7	8
	5.09	3.81	2.64	6.39	0.75	1.22	4.89	0.47
	11.26	8.93	7.60	11.59	12.15	6.08	5.39	2.85
	5.12	4.57	6.43	4.00	4.52	1.60	1.52	1.34
	5.14	1.74	1.73	4.39	1.76	2.69	3.17	0.67
	8.72	5.83	2.59	9.92	1.78	1.76	1.88	0.22
	6.55	2.12	4.52	3.70	1.37	1.64	2.03	3.65
	L	R	L	L	L	R	L	R
	R	L	R	R	R	L	L	L

Day	9	10	11	12	13	14	15	16
	2.99	0.38	0.66	2.58	3.39	1.15	0.91	4.25
	4.96	5.29	3.06	0.15	2.82	1.59	2.56	4.97
	1.34	1.01	1.07	4.01	1.98	1.34	1.36	1.46
	1.86	1.42	1.50	0.85	0.60	0.43	0.46	4.20
	1.79	1.00	2.45	1.70	1.64	1.42	2.04	3.90
	1.98	0.89	0.82	1.08	0.65	0.85	0.96	1.15
	R	L	L	L	L	R	L	R
	L	R	R	R	R	R	L	R

Subject Number: 29

Group: I-150

Day	1	2	3	4	5	6	7	8
	13.79	6.56	7.53	1.14	3.38	2.54	1.77	3.42
	46.79	2.82	6.05	17.74	2.74	8.06	5.03	3.07
	4.22	4.52	3.06	3.35	4.68	5.81	6.46	3.33
	6.63	3.05	1.78	4.08	2.63	0.96	0.49	1.94
	3.07	3.37	4.51	1.49	3.03	2.14	5.68	3.30
	3.09	1.36	2.21	2.12	1.54	3.52	0.96	2.83
	L	L	L	L	L	L	L	L
	R	R	R	L	R	R	R	L

Day	9	10	11	12	13	14	15	16
	1.56	0.89	7.40	1.35	0.92	3.06	3.76	2.09
	9.52	11.82	0.87	6.38	10.07	7.47	13.28	7.49
	3.28	3.06	1.56	2.01	1.69	2.26	1.87	1.92
	0.95	0.11	1.40	0.12	4.43	2.37	4.19	1.12
	1.15	3.85	0.65	2.92	1.35	1.66	2.49	1.12
	1.01	1.80	1.22	4.92	1.64	0.66	1.75	0.77
	L	L	L	R	R	R	R	R
	R	R	R	L	L	L	R	L

Subject Number: 26

Group: I-150

Day	1	2	3	4	5	6	7	8
	9.47	2.67	1.72	2.47	1.69	14.58	2.90	2.92
	36.53	85.75	206.28	178.39	352.29	296.43	165.72	137.35
	9.79	14.14	15.00	15.00	15.00	15.00	15.00	15.00
	2.27	0.64	1.78	0.90	9.71	1.07	6.89	5.06
	9.52	107.00	465.00	223.65	71.30	74.78	215.95	37.58
	5.93	15.00	15.00	15.00	15.00	15.00	15.00	6.52
	L	R	R	L	L	R	R	L
	R	R	L	R	L	R	R	L

Day	9	10	11	12	13	14	15	16
	2.24	2.90	3.31	1.58	1.00	2.36	2.22	0.64
	81.40	6.11	10.12	9.14	6.22	9.69	35.12	4.34
	3.40	2.74	2.94	1.67	2.45	3.24	3.46	1.91
	1.64	3.54	1.90	1.62	12.10	0.75	0.73	4.11
	4.80	0.55	16.91	3.93	5.78	34.41	3.43	0.89
	1.68	13.00	2.50	1.54	1.77	2.03	1.02	1.20
	R	R	R	R	L	L	L	L
	R	L	L	L	R	L	L	L

Subject Number: 22

Group: S-30

Day	1	2	3	4	5	6	7	8
	7.81	2.36	2.23	2.30	2.86	1.12	2.06	0.76
	10.35	11.50	12.67	46.74	26.98	5.74	42.30	3.79
	9.86	4.83	3.90	5.55	7.42	0.82	7.34	1.58
	3.29	2.07	2.35	10.34	4.27	2.07	4.32	0.77
	7.83	12.54	15.21	4.38	25.54	9.49	0.31	1.28
	8.42	2.50	5.00	4.28	2.82	1.75	1.75	1.75
	L	R	R	R	L	R	L	L
	R	R	L	L	R	L	R	R

Day	9	10	11	12	13	14	15	16
	5.35	3.73	1.25	2.03	2.61	1.38	1.42	1.94
	5.77	1.17	2.75	2.44	1.68	1.24	1.25	3.13
	1.30	9.98	1.58	1.66	1.90	1.20	3.83	1.63
	2.44	0.65	2.09	0.36	0.65	1.64	4.74	0.74
	3.82	2.72	1.20	2.37	0.84	1.50	2.64	1.71
	1.75	1.20	0.92	2.51	0.69	1.25	1.88	1.15
	L	L	L	L	L	L	L	L
	R	R	R	R	R	R	L	R

Subject Number: 5

Group: S-30

Day	1	2	3	4	5	6	7	8
	3.49	1.55	6.65	1.60	2.02	1.32	6.38	2.60
	5.30	5.65	4.22	3.13	5.10	1.33	4.85	6.74
	2.76	4.10	3.24	3.07	6.96	1.51	1.67	2.09
	2.76	4.12	7.72	6.59	11.68	0.95	5.75	2.75
	6.81	2.82	4.82	5.33	6.21	6.43	4.85	1.25
	3.65	12.56	6.54	5.88	5.50	1.76	1.72	1.81
	L	L	L	R	L	L	L	L
	R	L	L	L	R	R	R	R

Day	9	10	11	12	13	14	15	16
	1.42	1.71	2.91	0.66	3.87	2.07	1.38	1.24
	3.44	2.20	2.66	5.55	1.88	2.21	4.32	1.00
	1.21	1.81	1.99	1.96	2.41	1.61	1.84	1.97
	1.15	3.05	1.06	2.46	2.69	1.92	1.69	0.44
	4.01	0.33	0.96	1.73	4.21	1.13	2.18	1.21
	1.75	0.24	1.26	4.57	1.57	1.39	1.61	2.74
	R	R	L	R	L	L	L	L
	L	L	R	L	L	R	R	R

Subject Number: 10

Group: S-30

Day	1	2	3	4	5	6	7	8
	9.25	1.47	2.29	9.16	3.93	1.35	3.32	3.38
	5.00	2.26	4.32	1.57	0.94	3.40	3.46	2.42
	4.37	4.84	2.54	3.67	2.03	3.50	1.08	1.03
	1.46	5.80	0.97	6.51	0.82	0.57	2.36	1.98
	4.12	1.80	3.93	1.00	2.34	1.71	1.55	0.11
	4.94	4.95	0.92	2.83	0.77	0.79	0.96	1.21
	R	R	L	R	R	R	L	R
	L	L	R	R	L	L	R	L

Day	9	10	11	12	13	14	15	16
	0.83	2.06	9.59	6.76	1.47	3.11	2.57	0.80
	2.68	3.16	2.98	11.63	3.74	3.73	0.97	1.44
	0.91	1.50	2.51	5.76	1.89	2.59	1.10	1.42
	0.68	0.66	0.63	4.38	1.17	0.86	2.07	0.58
	1.91	2.57	2.01	4.76	2.01	2.08	1.68	6.93
	0.91	1.02	1.94	14.40	1.10	0.97	1.04	1.29
	R	R	L	L	R	L	L	R
	L	L	R	R	L	R	R	L

Subject Number: 14

Group: 8-30

Day	1	2	3	4	5	6	7	8
	6.44	1.30	4.93	3.24	1.13	1.98	1.79	7.10
	7.81	3.47	7.43	3.16	4.93	2.10	3.60	1.11
	6.06	14.82	2.74	3.12	2.34	1.27	1.27	1.51
	3.20	5.12	1.55	1.68	0.46	4.22	1.00	7.12
	2.71	3.18	2.49	1.58	1.19	3.69	3.42	5.58
	4.93	4.50	2.15	1.88	0.90	0.85	0.72	2.08
	L	R	L	L	L	R	L	R
	R	L	L	R	R	L	R	L

Day	9	10	11	12	13	14	15	16
	3.57	0.99	0.80	0.84	2.02	1.55	0.62	2.18
	1.89	2.36	2.74	2.78	1.94	2.83	2.72	4.84
	3.51	2.14	2.46	2.50	2.17	2.85	1.59	1.85
	0.57	0.35	1.85	1.62	1.95	0.93	0.74	0.72
	2.94	4.87	1.32	1.08	0.74	1.61	0.40	13.89
	1.31	1.63	0.93	1.10	0.53	0.62	1.29	1.50
	R	R	R	R	L	R	L	L
	L	L	L	L	R	L	L	R

Subject Number: 1

Group: S-150

Day	1	2	3	4	5	6	7	8
	20.29	6.33	5.54	4.89	4.05	10.66	27.69	3.55
	10.70	30.39	51.83	25.92	35.49	44.55	4.88	37.45
	5.04	7.23	12.40	8.65	6.20	1.19	3.49	0.60
	3.60	5.20	4.54	1.04	0.59	1.23	0.95	2.82
	7.53	12.25	19.67	4.45	1.25	6.02	3.44	1.42
	9.62	6.31	4.42	4.77	1.19	15.00	17.90	1.03
	R	R	R	L	R	L	R	L
	R	L	R	R	R	R	L	R

Day	9	10	11	12	13	14	15	16
	3.16	4.80	5.66	3.70	6.59	12.62	6.77	3.30
	27.00	15.00	0.17	2.41	4.01	12.25	15.44	17.26
	2.04	3.19	10.43	0.69	1.64	1.54	1.78	1.21
	1.21	0.46	2.75	1.83	1.14	1.54	2.59	2.26
	2.13	6.64	4.73	5.32	0.09	4.48	3.10	2.74
	1.22	2.94	1.40	2.10	7.72	1.17	1.52	1.12
	R	L	R	R	R	L	R	L
	R	L	R	L	R	L	R	R

Subject Number: 24

Group: S-150

Day	1	2	3	4	5	6	7	8
	2.14	1.21	0.57	1.50	0.78	0.55	1.09	0.45
	7.11	5.50	7.15	4.61	3.79	2.06	6.04	4.78
	4.31	4.30	2.37	2.60	2.18	3.30	1.41	3.19
	1.31	0.90	0.65	0.43	1.79	0.41	0.57	0.96
	4.33	4.35	3.66	3.58	1.45	3.28	5.03	2.34
	2.68	3.20	4.12	11.06	1.23	1.87	1.01	0.83
	L	R	L	R	R	L	L	L
	R	R	L	R	L	L	R	R

Day	9	10	11	12	13	14	15	16
	2.21	1.03	0.68	2.50	1.35	1.65	1.09	0.34
	23.15	4.81	5.35	3.06	1.84	1.90	4.07	2.25
	4.00	2.22	2.90	2.07	2.65	1.15	1.35	9.36
	1.09	0.87	0.68	0.45	2.40	1.82	2.80	1.80
	3.52	1.41	0.38	0.97	1.52	3.78	2.76	3.76
	1.36	1.28	0.60	3.48	2.70	0.96	2.23	0.97
	R	R	R	R	R	L	R	R
	L	L	L	L	L	R	L	L

Subject Number: 23

Group: S-150

Day	1	2	3	4	5	6	7	8
	7.29	1.13	4.11	4.48	2.19	2.11	4.74	1.92
	4.59	8.76	7.49	14.75	16.70	4.87	6.47	5.86
	10.00	6.28	4.28	6.41	2.25	2.44	0.92	1.57
	2.27	1.92	7.76	3.11	5.71	0.11	4.65	1.46
	4.53	44.94	5.97	8.92	2.42	1.95	2.67	3.66
	8.27	15.00	1.46	3.03	1.60	1.70	1.37	0.86
	L	L	L	R	L	L	L	L
	R	R	L	L	R	R	R	L

Day	9	10	11	12	13	14	15	16
	7.85	4.577	4.65	1.34	4.13	3.84	1.90	1.59
	71.15	4.58	12.22	8.39	35.46	1.16	3.12	21.81
	11.85	1.91	1.87	1.71	2.04	9.94	1.49	2.14
	1.40	1.64	9.02	2.85	0.46	2.46	9.24	4.27
	14.76	3.18	2.00	8.47	3.53	3.56	0.82	1.45
	3.64	1.61	2.10	1.97	2.00	2.32	1.16	1.15
	R	L	L	L	L	L	L	L
	L	R	R	R	R	R	R	R

Subject Number: 30

Group: S-150

Day	1	2	3	4	5	6	7	8
	15.08	5.35	3.40	1.33	3.54	1.23	0.97	0.65
	14.68	21.03	5.00	6.77	7.02	2.99	3.93	2.96
	9.92	3.65	2.31	4.77	8.55	6.49	7.25	1.97
	2.95	2.20	5.46	2.30	4.20	1.67	2.41	0.90
	6.05	18.42	7.84	2.68	2.42	1.12	2.19	1.85
	8.25	6.94	2.33	3.62	6.78	3.60	10.04	1.34
	L	L	R	L	R	L	L	R
	L	L	R	R	L	R	L	L

Day	9	10	11	12	13	14	15	16
	3.31	0.79	1.96	0.62	3.60	2.42	1.38	0.43
	2.61	5.25	3.85	2.34	1.27	0.54	2.42	2.85
	2.02	1.94	2.25	2.24	0.78	0.73	1.43	3.24
	0.57	5.56	0.45	1.20	5.90	1.70	0.99	4.56
	1.86	1.62	1.26	1.54	1.65	1.17	19.26	1.30
	1.02	1.43	2.96	0.79	1.69	1.11	1.19	0.99
	R	L	R	R	L	R	L	L
	L	R	L	L	R	L	R	R

Subject Number: 37

Group: S-15

Day	1	2	3	4	5	6	7	8
	7.95	3.97	9.48	1.98	1.63	9.52	1.27	4.29
	10.98	17.22	3.68	5.39	6.61	3.84	6.66	5.21
	2.94	0.09	4.35	2.75	2.56	15.00	1.48	2.60
	6.78	3.20	1.52	1.90	1.80	0.85	0.95	0.36
	5.94	11.72	4.04	2.29	3.60	4.34	2.69	2.81
	7.10	3.09	1.93	4.78	2.58	0.72	1.51	0.77
	R	R	R	R	R	L	R	L
	L	L	L	L	L	R	L	L

Day	9	10	11	12	13	14	15	16
	2.45	1.02	5.25	2.94	3.86	3.23	1.74	1.84
	4.55	3.87	6.96	2.22	3.22	13.51	6.45	25.41
	1.43	1.93	6.64	2.19	4.05	2.71	1.70	1.65
	9.87	2.01	1.81	3.56	0.61	1.14	0.83	1.36
	1.12	1.26	1.89	1.17	1.79	1.43	15.23	1.06
	1.19	0.81	0.22	1.11	0.91	1.16	3.22	1.18
	R	L	R	R	R	L	R	L
	L	L	L	L	L	R	L	R

Subject Number: 20

Group: S-15

Day	1	2	3	4	5	6	7	8
	8.85	4.02	1.58	2.94	3.68	0.89	1.18	0.59
	28.65	15.07	7.11	5.57	1.89	3.19	1.88	1.70
	4.90	2.34	3.12	3.02	2.94	1.17	1.28	1.09
	2.04	1.09	0.83	6.58	0.61	0.69	0.62	0.34
	0.65	4.01	5.55	1.38	1.12	3.57	1.94	0.69
	4.67	5.53	0.88	1.98	1.06	0.81	1.29	0.55
	R	L	R	R	L	R	L	R
	L	R	R	L	R	L	L	L

Day	9	10	11	12	13	14	15	16
	1.09	0.66	0.81	0.44	0.46	0.61	0.65	0.93
	2.41	0.56	0.94	1.50	1.84	2.85	3.13	2.81
	1.99	1.26	1.18	0.93	1.28	1.45	1.23	1.25
	0.67	0.32	0.98	1.34	1.92	4.63	1.31	0.26
	1.83	0.75	1.30	1.57	1.29	1.47	1.54	2.47
	1.18	0.74	1.15	0.80	0.57	1.09	0.81	1.49
	R	R	L	R	R	L	L	L
	R	L	R	L	L	L	R	L

Subject Number: 13

Group: S-15

Day	1	2	3	4	5	6	7	8
	3.78	4.04	2.11	1.92	1.70	1.47	0.74	0.52
	11.86	4.20	5.33	2.56	4.66	2.72	5.71	4.92
	5.61	15.00	3.28	3.00	2.60	1.54	1.59	1.14
	4.21	0.11	1.24	0.98	1.00	0.59	7.11	1.66
	0.61	6.00	5.67	1.69	1.04	2.10	2.22	0.56
	2.49	8.51	2.32	1.58	2.24	0.80	3.65	0.52
	R	L	R	R	R	L	L	R
	L	R	L	L	L	R	R	L

Day	9	10	11	12	13	14	15	16
	7.11	0.87	0.90	0.65	1.99	3.10	3.04	0.37
	10.78	4.76	4.87	1.22	2.13	3.29	1.93	2.90
	7.04	1.50	1.53	1.44	1.54	2.15	2.04	1.27
	4.41	9.41	1.53	2.27	1.92	1.41	3.45	1.86
	7.11	1.24	2.02	0.63	0.65	1.15	3.34	10.46
	6.15	1.25	0.80	0.87	0.53	1.12	3.84	4.43
	R	L	R	L	R	R	L	L
	L	R	L	R	L	L	R	L

Subject Number: 38

Group: S-15

Day	1	2	3	4	5	6	7	8
	24.95	36.70	46.90	27.80	16.35	15.16	1.54	14.88
	52.75	105.15	41.60	4.62	11.94	0.64	4.63	2.09
	13.85	15.00	15.00	12.09	3.41	2.50	1.09	2.28
	7.04	70.36	29.24	10.00	3.40	5.55	0.88	1.00
	30.53	35.11	67.85	29.29	3.89	1.38	4.93	3.14
	15.00	15.00	15.00	8.00	1.70	2.00	3.81	1.39
	L	R	L	R	R	R	R	R
	R	L	R	R	R	R	L	R

Day	9	10 *	11	12	13	14	15	16
	2.54	1.51	4.63	2.69	2.41	15.50	3.49	3.72
	4.37	3.54	5.80	2.43	3.18	2.88	3.21	1.28
	1.66	1.42	1.51	1.33	1.62	1.15	1.90	1.14
	1.12	1.26	0.98	0.63	2.03	3.01	0.35	1.52
	0.52	1.65	1.37	2.14	0.76	1.17	1.07	1.57
	2.51	1.14	0.75	0.95	2.15	1.51	1.18	2.14
	R	R	R	R	R	R	R	R
	L	R	R	R	L	L	L	L

Subject Number: 12

Group: D-150

Day	1	2	3	4	5	6	7	8
	13.54	0.64	6.25	1.55	0.87	1.45	2.25	1.74
	2.56	5.32	5.89	0.40	6.43	4.83	4.27	1.77
	2.48	13.37	1.50	6.09	1.43	2.87	2.25	2.05
	2.96	1.62	1.34	1.73	5.94	5.04	0.75	0.81
	5.04	7.54	4.21	3.95	2.99	1.27	2.27	1.08
	7.51	4.33	3.30	2.00	1.76	2.95	1.17	2.20
	R	L	L	R	R	L	L	R
	L	R	R	R	R	L	R	L

Day	9	10	11	12	13	14	15	16
	2.59	1.60	1.26	0.95	2.02	2.26	2.13	1.77
	1.69	0.12	3.67	2.55	0.82	4.13	3.06	3.12
	2.21	6.96	2.86	1.64	4.66	1.96	1.74	1.66
	3.68	0.45	2.64	0.51	2.86	2.64	0.71	0.47
	0.94	5.62	1.25	5.81	2.22	9.16	0.12	1.37
	1.24	1.30	0.98	1.40	2.06	3.06	3.63	3.05
	L	L	L	R	L	L	L	R
	R	R	R	L	L	L	R	L

Subject Number: 18

Group: D-150

Day	1	2	3	4	5	6	7	8
	38.00	12.27	13.02	8.96	6.06	8.80	5.41	3.12
	47.62	79.51	47.31	31.41	5.98	37.10	4.63	39.49
	11.73	7.50	15.00	5.47	11.57	10.52	6.50	4.34
	1.62	1.60	1.30	2.58	6.30	1.61	2.80	1.01
	5.17	34.00	30.09	2.37	5.84	1.59	3.68	1.76
	14.00	14.90	12.00	1.40	4.40	5.12	2.98	3.01
	R	L	R	R	L	R	L	R
	L	R	L	R	L	L	L	L

Day	9	10	11	12	13	14	15	16
	7.21	4.92	1.85	17.45	6.52	2.46	2.66	1.66
	15.20	14.21	5.00	2.11	10.44	1.99	5.53	7.68
	9.81	4.21	3.60	5.22	2.63	0.49	8.65	2.25
	1.87	4.40	5.08	3.80	2.01	0.87	0.63	3.18
	6.04	2.17	1.24	2.97	0.51	1.53	1.52	1.32
	6.31	0.77	1.89	2.21	0.92	0.83	1.23	1.54
	L	L	L	L	L	L	L	L
	R	R	R	R	R	R	L	L

Subject Number: 7

Group: D-150

Day	1	2	3	4	5	6	7	8
	12.89	7.28	1.69	4.56	5.55	5.89	2.35	1.91
	29.30	14.60	53.87	2.55	3.31	1.08	2.30	0.12
	6.61	3.47	1.90	2.44	2.03	1.82	1.41	1.50
	1.69	6.47	4.11	2.70	1.03	0.59	1.41	1.88
	27.83	4.82	0.55	1.65	1.89	1.60	4.00	1.17
	6.00	1.29	1.26	1.30	1.21	1.30	3.31	1.12
	R	L	R	L	R	L	R	L
	R	L	R	L	R	L	L	L

Day	9	10	11	12	13	14	15	16
	0.76	0.59	3.01	1.34	1.70	1.76	2.67	2.03
	2.59	2.55	3.96	1.33	1.69	2.68	3.20	5.28
	3.30	1.13	1.48	1.06	1.22	1.06	1.83	1.51
	0.49	0.39	0.64	0.14	3.02	1.75	1.67	1.05
	1.37	1.55	7.42	7.51	4.06	3.46	2.05	3.68
	1.21	1.02	0.89	1.73	1.37	0.94	1.04	1.03
	L	R	R	L	R	L	R	L
	R	L	R	L	R	L	R	L

Subject Number: 27

Group: D-150

Day	1	2	3	4	5	6	7	8
	8.50	2.10	3.06	3.82	5.53	1.98	1.71	1.25
	3.77	7.67	7.92	6.93	7.04	2.80	1.31	5.31
	5.06	2.47	4.37	4.60	4.40	5.50	4.32	7.38
	7.39	1.28	1.34	1.60	1.42	3.11	2.17	0.84
	3.53	4.10	4.85	2.58	1.42	1.34	4.94	1.42
	2.40	1.56	2.26	1.68	1.52	1.75	1.20	2.77
	R	R	L	R	L	R	L	R
	R	L	R	R	L	L	R	R

Day	9	10	11	12	13	14	15	16
	1.01	2.25	1.74	1.00	4.28	13.05	1.02	1.78
	3.12	5.17	2.84	5.28	2.67	5.79	3.91	9.85
	4.91	3.61	2.25	3.00	2.44	2.94	1.55	1.77
	0.63	0.55	1.65	2.79	3.82	0.54	0.86	0.48
	1.02	2.05	1.81	0.48	0.51	3.88	1.33	4.95
	2.15	3.05	0.86	0.79	1.77	0.94	1.45	2.09
	L	R	L	L	R	R	L	L
	R	L	R	R	R	L	R	R

Subject Number: 25

Group: D-15

Day	1	2	3	4	5	6	7	8
	10.02	2.97	1.25	4.54	2.13	1.47	1.72	1.17
	36.00	22.14	3.80	1.58	1.93	2.81	3.09	0.41
	2.81	1.68	1.13	3.30	1.69	2.32	1.30	0.78
	16.03	2.22	0.93	1.30	1.26	0.81	1.24	0.77
	3.27	14.17	2.23	1.61	0.64	2.16	2.88	0.12
	3.32	1.71	1.03	0.94	0.97	1.33	1.42	0.72
	L	R	R	R	R	L	L	R
	R	R	R	R	R	L	R	R

Day	9	10	11	12	13	14	15	16
	0.85	0.84	0.68	0.73	2.16	1.20	1.42	3.26
	2.68	16.90	2.77	1.07	1.45	1.52	0.76	1.02
	1.19	1.78	1.21	1.08	1.08	0.70	0.91	1.04
	0.75	0.24	0.52	0.89	0.64	0.89	0.16	0.63
	1.95	1.51	0.94	2.75	1.08	1.86	1.06	2.44
	1.50	0.69	0.85	0.48	2.20	0.57	1.81	0.61
	L	L	L	R	L	L	L	L
	R	R	R	R	R	L	R	R

Subject Number: 19

Group: D-15

Day	1	2	3	4	5	6	7	8
	16.21	7.46	6.54	9.01	11.97	1.03	1.64	1.64
	8.11	6.04	79.83	23.75	4.13	11.56	3.54	0.55
	4.70	2.50	15.00	2.21	5.19	1.59	1.29	1.29
	1.11	0.99	16.43	22.32	7.54	11.36	3.00	1.15
	10.78	20.71	9.93	13.55	1.74	0.96	1.20	1.79
	9.32	2.34	1.73	2.21	1.99	2.81	1.07	0.98
	L	R	R	R	L	R	L	L
	R	L	L	R	L	L	L	R

Day	9	10	11	12	13	14	15	16
	0.72	3.39	3.69	1.02	2.00	1.09	2.64	8.04
	7.33	7.87	3.18	5.68	1.33	1.10	1.74	5.60
	1.12	1.06	1.46	1.05	0.76	2.52	1.32	1.24
	6.09	12.56	5.04	2.82	1.63	4.02	3.84	1.70
	1.61	2.76	1.41	1.54	6.44	9.20	3.36	2.85
	1.18	1.36	1.69	0.90	1.42	1.27	1.14	1.21
	L	L	L	R	L	L	L	R
	R	R	R	L	R	R	R	L

Subject Number: 36

Group: D-15

Day	1	2	3	4	5	6	7	8
	10.42	3.49	4.63	1.06	1.18	5.34	3.06	0.71
	29.00	6.68	2.53	2.32	2.20	3.85	5.28	1.85
	5.32	2.52	2.41	6.43	2.07	1.69	2.69	1.71
	5.64	1.74	0.18	0.76	1.08	0.81	0.59	0.47
	1.56	3.79	6.94	2.76	0.10	2.33	4.96	1.85
	5.31	2.02	11.18	2.44	2.44	1.54	1.35	1.33
	L	R	L	R	L	R	L	L
	R	R	R	L	R	L	R	R

Day	9	10	11	12	13	14	15	16
	1.00	0.62	0.70	0.36	0.44	0.61	1.68	0.39
	2.77	19.16	2.81	2.51	1.84	1.94	4.07	2.68
	1.51	4.11	1.24	1.41	1.28	1.26	1.61	1.98
	0.47	0.50	0.95	0.73	0.77	5.29	0.58	0.23
	0.54	9.89	1.32	1.92	1.91	4.41	2.03	1.29
	1.20	1.48	0.99	1.52	1.62	2.03	2.05	2.35
	L	L	L	R	R	L	R	R
	R	L	R	L	L	R	R	L

Subject Number: 34

Group: D-15

Day	1	2	3	4	5	6	7	8
	9.30	5.85	7.12	6.45	3.20	4.96	13.53	3.45
	13.57	10.55	68.15	133.14	131.26	133.89	9.43	7.96
	6.45	13.40	15.00	15.00	15.00	15.00	3.39	4.90
	7.27	4.74	28.44	6.11	14.34	21.89	2.90	1.93
	5.70	56.69	73.32	38.44	55.88	30.74	11.80	4.40
	4.60	15.00	15.00	15.00	15.00	15.00	2.37	3.46
	L	R	L	L	R	L	R	L
	L	L	L	R	R	L	R	L

Day	9	10	11	12	13	14	15	16
	2.12	0.79	3.37	2.65	0.99	1.13	0.92	1.66
	32.80	4.39	5.10	1.19	3.09	2.00	2.91	4.72
	8.70	2.04	2.91	5.57	1.95	1.41	1.56	1.64
	0.81	1.50	0.57	2.71	1.64	0.93	1.34	3.19
	1.87	5.08	1.44	1.41	1.84	2.44	2.24	1.10
	1.74	1.35	1.06	0.87	1.21	5.45	2.62	0.71
	R	L	R	L	R	L	R	L
	R	L	R	L	R	R	L	L

Subject Number: 41

Group: D-30

Day	1	2	3	4	5	6	7	8
	9.97	0.95	1.00	0.64	0.75	3.60	4.53	0.80
	12.71	5.94	3.20	2.11	1.00	1.19	3.75	1.43
	11.39	1.85	1.53	1.42	1.45	1.04	3.81	1.24
	0.94	0.50	1.29	0.63	1.47	0.87	1.55	1.05
	0.10	2.93	2.69	1.36	1.18	0.80	1.15	1.68
	5.64	3.31	1.08	1.92	0.81	0.86	1.30	3.16
	L	L	R	L	R	L	L	L
	R	R	L	R	L	L	R	R

Day	9	10	11	12	13	14	15	16
	0.55	0.53	2.11	0.75	0.42	0.71	0.51	1.24
	3.38	2.84	1.66	1.88	0.22	1.15	1.35	2.45
	1.09	0.79	0.66	0.89	2.04	0.65	0.75	0.96
	0.61	0.40	0.45	0.24	0.59	2.07	1.29	0.90
	1.21	3.45	2.46	1.61	1.35	1.49	0.97	2.18
	1.13	0.69	0.45	0.79	0.80	1.10	1.21	0.91
	L	R	L	L	L	L	L	L
	L	R	L	L	R	L	L	L

Subject Number: 17

Group: D-30

Day	1	2	3	4	5	6	7	8
	4.30	9.68	0.86	3.78	1.61	1.69	3.28	4.42
	2.41	3.23	3.58	1.80	4.69	1.00	2.35	2.91
	3.31	2.09	1.90	2.34	3.18	3.58	1.92	1.39
	1.47	9.40	6.13	2.03	1.06	0.78	5.83	0.84
	2.29	4.00	1.54	1.91	2.50	1.09	0.11	2.82
	3.27	3.05	2.59	3.52	1.79	4.31	4.84	3.71
	L	L	R	R	L	L	R	R
	R	L	L	L	R	R	R	R

Day	9	10	11	12	13	14	15	16
	1.90	0.09	2.31	0.64	3.62	0.96	0.97	0.89
	3.32	1.28	1.17	8.44	3.29	4.06	8.64	2.44
	2.34	1.51	1.55	1.89	1.84	9.15	5.04	1.23
	0.58	0.80	0.75	1.89	1.81	0.50	1.30	0.70
	3.36	2.71	2.14	1.47	0.55	9.86	1.88	1.08
	1.21	1.30	1.29	5.86	1.15	1.33	0.78	0.90
	L	L	R	R	L	L	L	R
	R	R	L	L	R	R	R	L

Subject Number: 2

Group: D-30

Day	1	2	3	4	5	6	7	8
	9.00	3.59	1.38	1.50	0.71	1.06	7.41	0.71
	6.39	9.51	3.14	22.23	2.65	0.35	1.85	3.09
	5.19	4.74	1.42	3.93	3.47	5.59	2.25	1.14
	0.10	1.10	0.75	1.54	1.44	1.02	0.48	1.08
	10.60	7.42	5.14	1.82	2.31	0.96	3.88	0.55
	3.40	4.77	2.38	1.61	1.33	2.32	1.05	2.26
	R	R	R	R	L	L	R	L
	L	L	L	L	R	L	L	L

Day	9	10	11	12	13	14	15	16
	0.47	0.40	0.35	0.85	0.48	0.54	0.51	1.15
	2.45	0.47	1.41	1.31	2.48	2.17	1.64	0.65
	1.16	0.98	0.63	0.86	0.89	1.17	0.68	1.62
	1.06	1.03	0.24	0.21	0.79	0.27	0.79	0.44
	0.53	1.69	1.35	1.39	1.20	1.25	1.83	1.20
	0.38	2.15	0.53	0.75	0.69	0.67	0.84	0.91
	L	R	R	L	R	R	R	L
	R	L	L	R	L	L	R	R

Subject Number: 39

Group: D-30

Day	1	2	3	4	5	6	7	8
	7.15	2.26	6.14	1.22	1.34	1.53	4.21	2.23
	28.35	11.59	9.33	5.36	4.84	3.27	2.42	1.59
	5.90	5.59	1.70	4.42	2.40	2.79	1.75	1.68
	4.37	1.74	0.88	1.38	2.70	1.01	0.75	0.35
	5.75	5.21	13.80	1.37	2.83	0.92	2.15	0.06
	15.00	3.22	1.47	3.49	1.68	1.85	1.09	1.74
	L	R	L	R	L	R	R	R
	R	L	R	L	R	L	L	L

Day	9	10	11	12	13	14	15	16
	2.23	1.31	0.54	0.79	0.40	1.69	0.51	0.90
	3.83	1.27	1.94	1.33	1.48	1.30	2.12	1.27
	1.38	1.43	1.02	2.35	0.77	1.87	1.27	1.18
	0.27	0.93	0.76	1.21	0.84	1.20	0.43	0.24
	2.65	1.37	1.17	1.38	2.40	1.64	1.49	1.43
	0.55	1.11	0.69	0.75	1.15	1.19	0.76	0.66
	R	R	R	R	R	R	R	R
	L	L	L	L	L	L	L	L

BIBLIOGRAPHY

Berlyne, D. E. *Conflict arousal and curiosity.* New York: McGraw-Hill, 1960

Dember, W. N. & Millbrook, B. A. Free choice by the rat of the greater of two brightness changes. *Psychol. Rep.*, 1956, 2, 465-467.

Dember, W. N. & Roberts, W. Alternation behavior in peripherally blinded rats. *Percept. Mot. Skills*, 1958.

Dember, W. N. & Fowler, H. Spontaneous alternation behavior. *Psychol. Bull.*, 1958, 55, 412-428.

Dennis, W. J. Spontaneous alternation in rats as an indicator of the persistence of stimulus trace. *J. comp. Psychol.*, 1939, 28, 305-312.

Dodge, R. The laws of relative fatigue. *Psychol. Rev.*, 1917, 24, 89-113.

Glanzer, M. Stimulus satiation: An explanation of spontaneous alternation and related phenomena. *Psychol. Rev.*, 1953, 60, 257-268. (a)

Glanzer, M. The rôle of stimulus satiation in spontaneous alternation *J. exp. Psychol.*, 1953, 45, 387-393. (b)

Glanzer, M. Curiosity, exploratory drive, and stimulus satiation. *Psychol. Bull.*, 1958, 55, 302-315.

Heathers, G. L. The avoidance of repetition of a maze reaction in the rat as a function of the time interval between trials. *J. Psychol.*, 1940, 10, 359-380.

Hull, C. L., *Principles of behavior.* New York: Appleton-Century-Crofts, 1943.

Jackson, M. M. Reactive tendencies in the white rat in running and jumping situations. *J. comp. Psychol.*, 1941, 31, 255-262.

Kivy, P. N., Earl, R. W., & Walker, E. L. Stimulus context and satiation. J. comp. Physiol. Psychol., 1956, 49, 90-92.

Ladieu, G. The effect of length of delay interval upon delayed alternation in the albino rat. J. comp. physiol. Psychol., 1944, 57, 273-286.

Montgomery, K. C. Spontaneous alternation as a function of time between trials and amount of work. J. exp. Psychol., 1951, 42, 82-93.

Montagomery, K. C. A test of two explanations of spontaneous alternation. J. comp. physiol. Psychol, 1952, 45, 287-293. (a)

Montgomery, K. C. Exploratory behavior and its relation to spontaneous alternation in a series of maze exposures. J. comp physiol. Psychol., 1952, 45, 50-57. (b)

Montgomery, K. C. Exploratory behavior as a function of "similarity" of stimulus situation. J. comp. physiol. Psychol., 1953, 46, 129-133.

Morgan, C. T. & Wood, W. M. Cortical localization of symbolic processes in the rat. II. Effects of cortical lesions upon delayed alternation in the rat. J. Neurophysiol., 1943, 6, 173-180. (As cited in Dember and Fowler, 1958)

Petrinovick, L. & Bolles, R. Delayed alternation: Evidence for symbolic processes in the rat. J. comp. physiol. Psychol., 1957, 50, 363-365.

Riley, D. A. & Shapiro, A. N. Alternation behavior as a function of effortfulness of task and distribution of trials. J. comp. physiol. Psychol., 1952, 45, 468-475.

Robinson, E. S. Work of the integrated organism. In Carl Murchison (Ed.), A handbook of general experimental psychology. Worcester, Mass.: Clark University Press, 1934. Pp. 571-650.

Rothkopf, E. Z. & Zeeman, D. Some stimulus controls of alternation behavior. J. Psychol., 1952, 34, 235-255.

Siegel, S. Nonparametric Statistics. New York: McGraw-Hill, 1956.

Sutherland, N. S. Spontaneous alternation and stimulus avoidance. J. comp. physiol. Psychol., 1957, 50, 358-362.

Walker, E. L., Dember, W. N., Earl, R. W., Fawl, C. L., & Karoly, A. J. Choice alternation: I. Stimulus vs. place vs. response. J. comp. physiol. Psychol., 1955, 48, 19-23. (a)

Walker, E. L., Dember, W. N., Earl, R. W., Fawl, C. L., & Karoly, A. J. Choice alternation: III. Response intensity vs. response discriminability. J. comp. physiol. Psychol., 1955, 48, 80-85. (b)

Walker, E. L. The duration and course of the reaction decrement and the influence of reward. J. comp. physiol. Psychol., 1956, 49, 167-176.

Walker, E. L. Action decrement and its relation to learning. Psychol. Rev., 1958, 65, 129-142.

Zeaman, D., & House, B. J. The growth and decay of reactive inhibition as measured by alternation behavior. J. exp. Psychol., 1951, 41, 177-186.

VITA

Vernon Stephen Bisese was born in Norfolk, Virginia on March 6, 1933. He attended Maury High School of Norfolk from 1948-1951. In 1951 he entered the University of Notre Dame in South Bend, Indiana and received the degree of Bachelor of Science in 1955. Mr. Bisese was employed by the Norfolk City School Board from 1956-1959 as a general science teacher in secondary schools. From 1959-1961, Mr. Bisese has been serving as a psychologist interne at Eastern State Hospital and attending the graduate school of the College of William and Mary as a candidate for the degree of Master of Arts.